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OLIVIER MODELS REMODELLED.

BY PROF. C. W. MACCORD.

The apparatus with which the Stevens Institute of Technology was provided at its opening in 1871, included, among those things specially relating to descriptive geometry, a small number of the celebrated "Olivier Models" for illustrating ruled surfaces. The distinguishing features of these models may be thus described: A series of holes is drilled in a rigid piece of metal, along a line representing one directrix of a surface, and in each of these is secured a thread or fine cord of silk; these cords run freely through a second series of holes in another rigid piece, representing the other directrix, and to the free end of each a small weight is attached. The cords, being thus kept always taut and consequently straight, form the rectilinear elements of the surface; and by making the rigid directrices adjustable, so that they can at pleasure be placed in different relative positions, the modifications of the surface, produced by varying conditions, may be exhibited in a very satisfactory manner.

This is a simple and elegant method of showing the formation of any surface upon which right lines can be drawn; and it affords a particularly happy means of illustrating the peculiarities of warped surfaces. These surfaces are universally admitted to present greater difficulties than any others to the student; who can in most cases gain a clearer conception and a better understanding of one of them by a brief examination of a model, than by protracted study of text and diagrams.

It will readily be seen that two or more surfaces may be represented in a single model; these may be tangent to each other, or they may mutually intersect, either normally or otherwise; and thus it would be possible to construct, in the manner above indicated, practical illustrations of a vast number of problems in which these different relations are involved.

This greatly widens the range of utility of such devices, because many find the questions relating to tangency and to intersection, especially in connection with warped surfaces, quite as perplexing as those relating to the forms and properties of the surfaces themselves.

Evidently the system above described is capable of extension almost without limit,—and indeed a very great number of such models has been made, illustrating a variety of surfaces and problems, both simple and complicated.

Such a multiplication of models, however, is of more than questionable advantage, particularly to the student of engineering. To him the greatest value of the abstract study of descriptive geometry lies in the development and strengthening of the imaginative power. His professional life will lead him, if he possesses the ambition which he should have, not to the mere copying of what has been done by others, but to attempting the accomplishment of things which have never been done at all. And in developing new designs, he will find that the power of stereoscopic vision which causes the bald outlines to stand out in full relief, presenting to his mental eye the just image of the completed work, is absolutely indispensable. This power is, like many others, to some extent a gift of nature, but it is one of those which are susceptible of cultivation; and it is best cultivated by judicious exercise. Being a purely mental power, its development will be best effected by mental processes, with as little dependence as may be upon physical illustrations.

That is to say, models should be used but sparingly in the

study of descriptive geometry. They may be advantageously used at the outset, as an aid to the requirement of familiarity with the methods of representing abstract magnitudes, such as lines and planes in space,—although even there pictorial representations will often prove equally effective. But they will be found of greater utility later on, in connection with more complex problems, and in exhibiting the formation of warped surfaces. Nor is any great number of models needed to render all the service requisite; indeed their best service is to illustrate not particular cases or minute variations, but rather general principles,—to give clear ideas of features common to whole classes,—after which the results of specialization should be left to be determined, as reasonable problems in the direct line of the study of the science, and exercises in its application. From this point of view, the original collection of Olivier models was sufficient in number; and with one or two exceptions they were judiciously selected.

But in one important respect they were all radically bad. It is a reasonable requirement that a model which is to be used in the instruction of students of mechanical engineering, should be made with proper regard to mechanical proportion, afford at least a fair example of judicious construction, and give evidence of thoughtful consideration in design. In these particulars, the models in question presented the best examples of bad practice that could have been procured; one after another they broke down repeatedly, until perseverance in repair ceased to be a virtue, and in their original forms they became utterly unserviceable. The materials and workmanship, however, were of the best; and some such models being almost indispensable, it was decided to employ such parts of the old ones as could be made available, in the construction of new ones more substantial, more durable, and more compact.

The first of these, shown in Fig. 1, illustrates the Circular

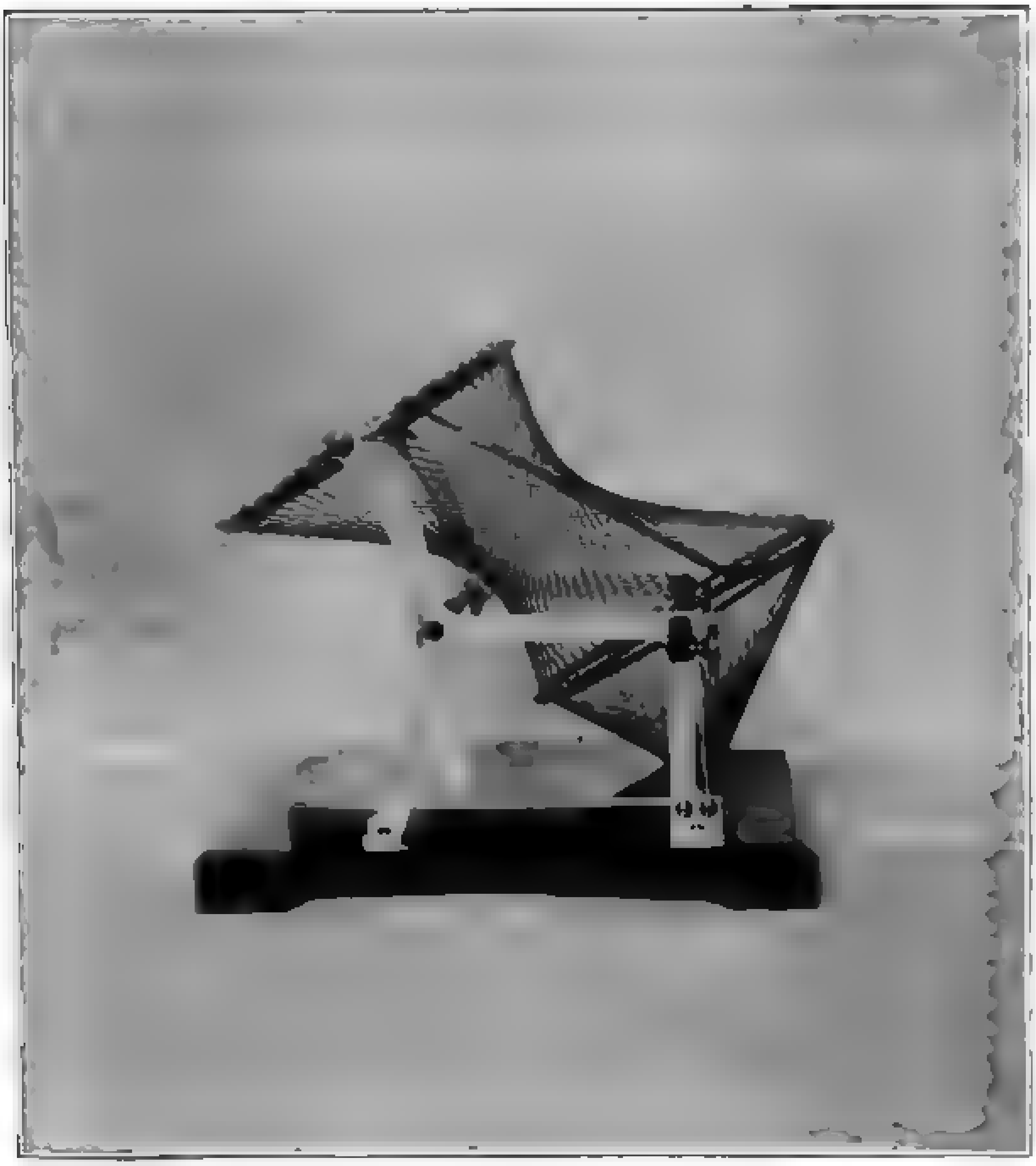


FIG. 2.

lighter and more compact than it could have been by the use of weights for producing the required tension.

But even retaining the weights, it was found possible to effect a great saving in space. In the original models, every weight had a vertical movement equal to the change in length of its suspending cord. By making use of pulleys or their equivalents, one-third of this movement was easily made to answer the purpose; and in this way the triangular box enclosing the weights, in the

FIG. [illegible]

model of the Parabolic Hyperboloid, Fig. 3, was reduced to one-half its former height. The weights, of course, in order to maintain the same tension, had to be increased in proportion to the diminished fall; but not to a total amount greater than the weight of the other half of the box.

Obviously, the height could have been still further reduced by the use of springs. In fact a model of this surface (now in the possession of Princeton University), of the same general dimensions as to the upper part, was made some twenty years ago

FIG. 4.

at the writer's suggestion. In that model the cords were wound upon barrels containing coiled springs, as in the familiar pocket tape measures; and all these were easily accommodated within a hollow iron base, about one-third as deep as the wooden box shown in Fig. 3.

In Fig. 4 is shown the reconstructed model of two intersecting cones; the vertices can be adjusted at different heights and at different distances apart, while the line joining those vertices is capable of rotating through a limited angle about a vertical axis, thus modifying the actual forms and changing the relative positions of the cones. Horizontal helical springs are here substituted

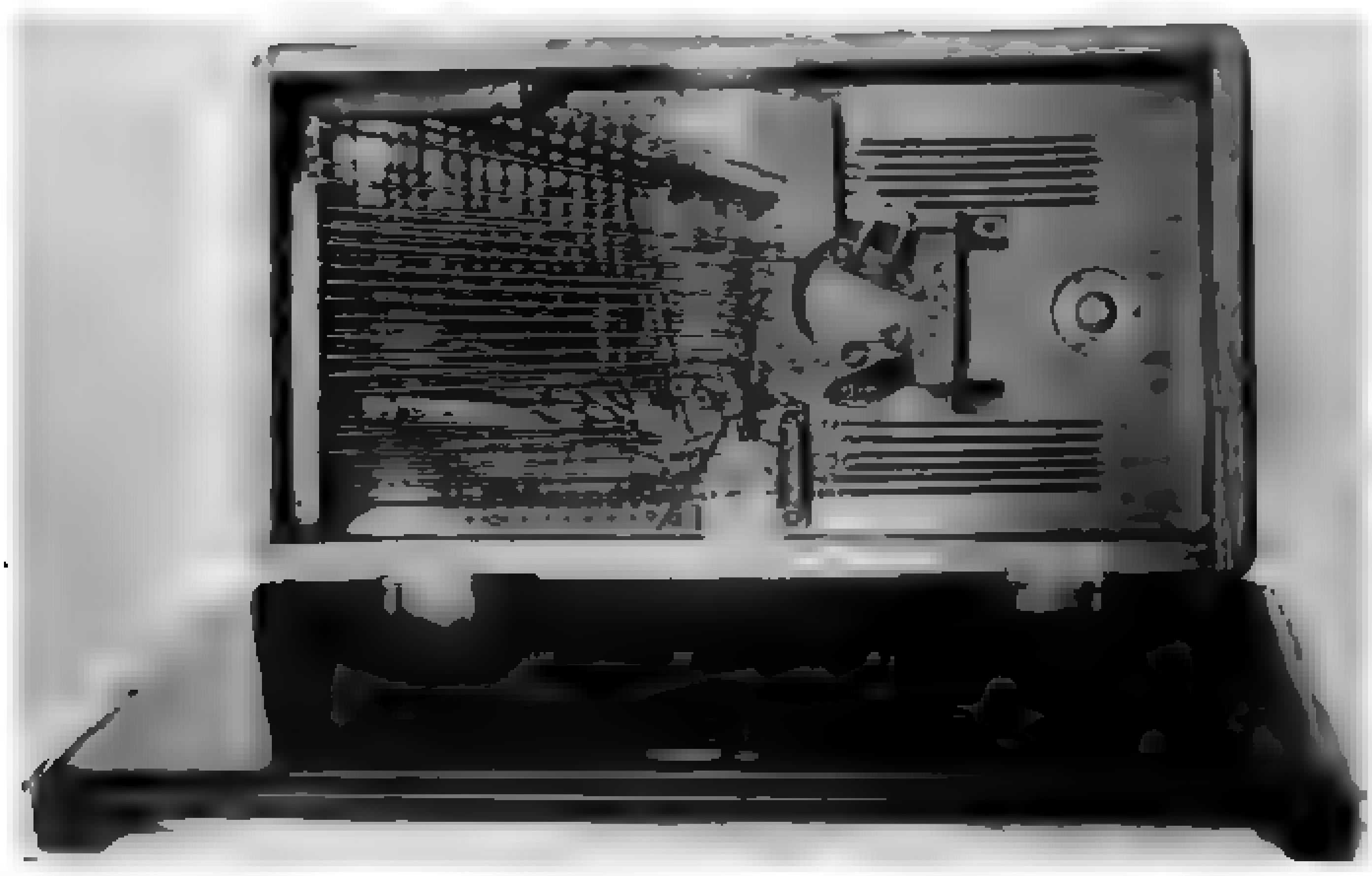


FIG. 5.

for the weights, as in Fig. 1; these are contained within the rectangular box, which is hinged to the base-board, and in Fig. 5 is shown turned upon its hinges in such a manner as to exhibit its contents and give some idea of the arrangement of the springs. Its depth is three inches; and it is merely the cover, or upper part, of the original box containing the weights, whose depth was eight inches additional. In space, then, a great saving was made, as these dimensions plainly prove. Whether the design of the upper part has or has not been improved in like proportion, it is not for us to decide—but it is safe to say that in the Parisian origi-

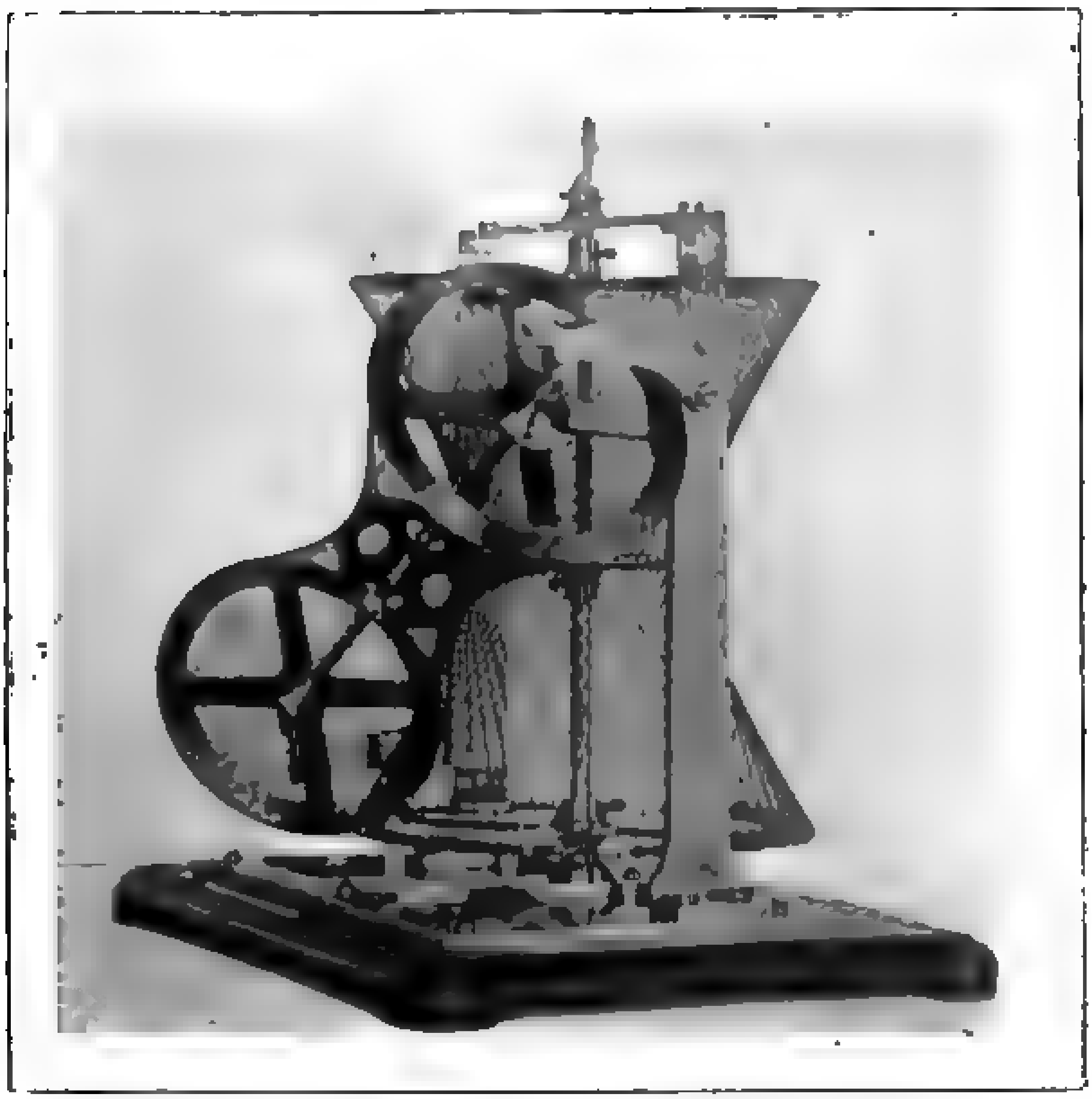


FIG. 6.

which accordingly was employed in stringing up the models herein illustrated.

Evidently, cords representing the elements of ruled surfaces can thus be stretched through holes in fixed pieces as well as in movable ones. In this way, some obscure relations between two or more surfaces may be clearly illustrated, in a single model, which cannot by any possibility be made adjustable. Thus, the model shown in Figs. 6 and 7, exhibits two Hyperboloids of Revolution, tangent to each other along a rectilinear element; and also a Parabolic Hyperboloid, normal to both those surfaces along that line of tangency. The elements of this common normal surface are represented by cords running through holes in the steel rods which represent the axes of the other two. It is obviously impossible to change the spacing of these holes; consequently the model, while exhibiting perfectly the mutual relations of the three surfaces as determined by one set of conditions, is in the nature of things incapable of being modified so as to satisfy any other conditions. But this inflexibility does not in the least detract from the value of the model,—since these relations of the three surfaces, which it makes clear at a glance, are among those which are proved by experience to be most difficult of apprehension. In fact, in regard to the practical application of these surfaces in mechanism, this model may rightly be considered the most useful of all those which have been described.

THE DETERMINATION OF THE COST OF ELECTRIC LIGHTING BY GAS ENGINE.*

BY J. L. CHRISTY, M. E., AND S. A. HASBROUCK, M. E.

The plant consists of a 10 H. P. gas engine, of the "Otto" type, belted to a counter-shaft and thence to an "Excelsior" dynamo of the Churchwood Four Pole type. A counter-shaft was used so that a dynamometer could measure the power delivered to the dynamo.

DESCRIPTION OF ENGINE.

The valves of the engine are both positive in action, being actuated by levers which receive their motion, at the proper time, by means of cams. These cams are keyed to a shaft at right angles to the main shaft and receiving its motion by means of gears of the "worm and wheel" type.

The air is taken from the base of the engine, thus muffling the sucking noise; while the gas is governed by a small valve worked at the proper time by the governor.

The governor is of the "pendulum" type; its method of operating being such that if the speed of the engine is too great the "toe" of the governor is lifted, thus missing the gas valve and preventing an explosion until the engine has resumed its proper speed.

The ignition is "hot-tube." The exhaust is first expanded into a large iron pot and then passes into the air.

The dynamo is a four-pole compound wound machine wi[th] carbon brushes, which feed perpendicular to the surface

* Abstract of Thesis, June, 1896.

the commutator, thus insuring the constancy of the "neutral" point.

The "mains" lead from the dynamo to the "bus-bars" of a marble switch-board; being controlled by a double knife switch. From the "bus-bars," mains, controlled by a double knife switch, lead to ten pull-switches, each controlling ten lights.

The "lights" are banked on a swinging board in the window and there is also a "pilot" light, across the brushes of the dynamo.

Each of the two main circuits and of the ten small circuits, is protected by fuses.

A Weston ammeter is on circuit from the dynamo and a Weston voltmeter is across the "bus-bars."

The shunt-field of the dynamo is controlled by a rheostat on the switch-board.

INDICATORS.

The indicators are the new form Tabor, the spring 207 lbs., as connected by a Crosby testing set. For a reducing motion a "Bromble" pulley was used.

The "Explosion" recorder designed and built by the writers, will be very easily understood by reference to the cut on page 19.

It is simply an indicator, whose piston area is one-quarter of a square inch, to reduce the shock of the explosion which moves the figures or dials of a revolution counter instead of a pencil.

The electrical instruments are the Weston standard and were accurately standardized at the electrical laboratory of the Institute.

THE TABLES.

The following tests contain the data taken at the engine; the averages for each test, and a table of comparison of costs at different loads.

TEST I.

No. of Card.	Rev. of Engine.	Explosions.	Gas Meter.	Volts.	Amperes.	No. of Lights.	Revolutions.	
							Dynamo.	Counter-shaft.
1	280	434553	9620	115	9.5	21	1280	498
2	284	......	....	112	9.1	21	1300	510
3	280	......	....	108	9.0	21	1320	520
4	280	......	....	110	9.5	21	1355	508
5	280	......	....	115	9.0	21	1390	512
6	280	......	....	112	9.0	21	1336	510
7	276	......	....	112	8.8	21	1338	500
8	280	......	....	109	8.5	21	1324	520
9	272	......	....	108	8.5	21	1320	500
10	280	......	....	107	9.0	21	1320	500
11	272	......	....	110	8.5	21	1360	520
12	270	......	....	108	8.8	21	1300	500
13	264	......	....	109	8.6	21	1332	500
14	268	......	....	109	8.5	21	1294	498
15	268	......	....	107	8.5	21	1340	500
16	272	......	....	107	8.4	21	1298	490
17	264	450619	10163	106	8.8	21	1260	490

Ignition tube requires 4 cubic feet of gas per hour.
Spring used, 207 lbs.
Bore of cylinder, 7 inches. Stroke, 13 inches.

TEST I.—CALCULATIONS.

Revolutions per minute	274.7	
Explosions (total)	16066.0	
" per minute	66.94	
Gas (total)	543.	ft.
" used by engine $=543.-4.\times4.$	527.	"
" per hour $527\div4$	131.75	"
" " " Indicated Horse Power	22.6	"
Volts	109.6	
Ampères	8.8	
Watts $=109.6\times8.8$	964.48	
Electrical H. P. $=\frac{964.48}{746}$	1.29	
M. E. P.	68.79	
Initial Pressure, Avg.	249.4	lbs. abs.
" " Highest	366.6	" "

" " Lowest . . . . 165.8 " "

I. H. P. $= \frac{13 \times 38.48 \times 66.94 \times 68.79}{12 \times 33000}$ . . 5.82 I. H. P.

Cost per hour, gas costing \$1.25 per 1000 cubic feet: $\frac{131.75}{1000} \times 1.25$ . . . \$0.165

Cost per lamp hour, $\frac{\$0.165}{21}$ . . . 0.78

TEST II.

The following set of readings were taken at intervals of 15 minutes, from 8.45 A. M. to 11.45 A. M.:

No. of Card.	Rev. of Engine.	Explosions.	Gas Meter.	Volts.	Amperes.	No. of Lights.	Revolutions.	
							Dynamo.	Counter-shaft.
1	256	382660	11561	108	36.	81	...	....
2	240	384470	....	106	35.5	..	....	....
3	248	386170	....	106	35.5	..	...	....
4	248	......	....	106	35.5	..	....	....
5	254	......	....	107	37.	..	....	....
6	254	......	....	108	37.5	..	....	....
7	254	......	....	108	37.5	..	....	....
8	256	......	....	110	38.	..	....	....
9	254	......	....	108	37.	..	....	....
10	264	......	....	112	39.	..	....	....
11	264	......	....	111	38.5	..	....	....
12	268	......	....	110	38.	..	....	....
13	268	12146	....	112	38.5	..	....	...
Avg.	256	585	....	108.6	37.2	..	....	....

Remarks:—

At 8.45 consumption, 180. ft.
" 9.45 " 211.7 "
" 10.15 " 196.5 "
" 10.50 " 196.7 "
" 11.30 " 181.8 "
" 11.45 " 182.8 "

CALCULATIONS OF TEST II.

Revolutions per minute . . . . . 256.

Explosions (total) $\frac{(256-4)}{2} \times 180$. 22320.

" per minute . . . . . 124.

Gas (total) . . . . 585.

" used by engine, $585-4 \times 3$ . . . 573.

Gas total per hour [illegible]	[illegible]
per I. H. P.	[illegible]
Volts	[illegible]
Amperes	[illegible]
Watts = [illegible]	[illegible]
Electrical H. P. = [illegible]	[illegible]
M. E. P.	[illegible] lbs.
Initial Pressure avg.	[illegible] lbs.
Highest	[illegible]
Lowest	[illegible]
I. H. P. = [illegible]	[illegible]
Cost per hour at $1.25 per 1000 cubic feet.	
[illegible]	$[illegible]
Cost per lamp per hour	[illegible]

TEST [illegible].

The following set of readings were taken at intervals of [illegible] minutes [illegible].

[illegible]	Time	[illegible]	Meter	Volts	Amperes	Lamps	Revolutions: Engine	Revolutions: Dynamo
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	195.5
6.30	195.6

CALCULATIONS OF TEST III.

Revolutions per minute	251.1	
Explosions (total)	14113.	
" per minute	117.6	
Gas (total)	398.	cu. ft.
" used by engine, $398-2\times4$	390.	" "
" used per hour $=\frac{390}{2}$	195.	" "
" used per hour per I. H. P.	20.28	" "
Volts	103.7	
Amperes	39.5	
Watts	4096.15	
Electrical H. P. $=\frac{4096.15}{746}$	5.49	
M. E. P.	64.67	lbs.
Initial Pressure, Average	293.69	lbs. abs.
" " Highest	308.64	" "
" " Lowest	283.80	" "
I. H. P. $=\frac{13\times38.48\times117.6\times64.67}{12\times33000}$	9.61	
Cost per hour at $1.25 per 1000 feet $\frac{195}{1000}\times1.25$	$0.244	
Cost per lamp per hour $\frac{.244}{88}$	0.277	

PRONY BRAKE TEST.

Time P. M.	No. of Card.	Rev. of Engine.	Explosions.	Gas.	Weight on Scales.
1.25	1	260	388881	13170	250 lbs.
1.30	2	272	......	.....	256
1.35	3	256	......	.....	250
1.40	4	256	......	.....	300
1.45	5	256	......	.....	250
1.50	6	272	......	.....	300
1.55	7	264	......	.....	300
2.00	8	272	......	.....	300
2.05	9	264	......	.....	300
2.10	10	240	......	.....	300
2.15	11	264	......	13355	300
2.20	12	264	394505	.....	300
Average.	..	258.3	5624	185	283.8

Remarks:—

Initial weight on scales=45 lbs.

CALCULATIONS OF PRONY BRAKE TEST.

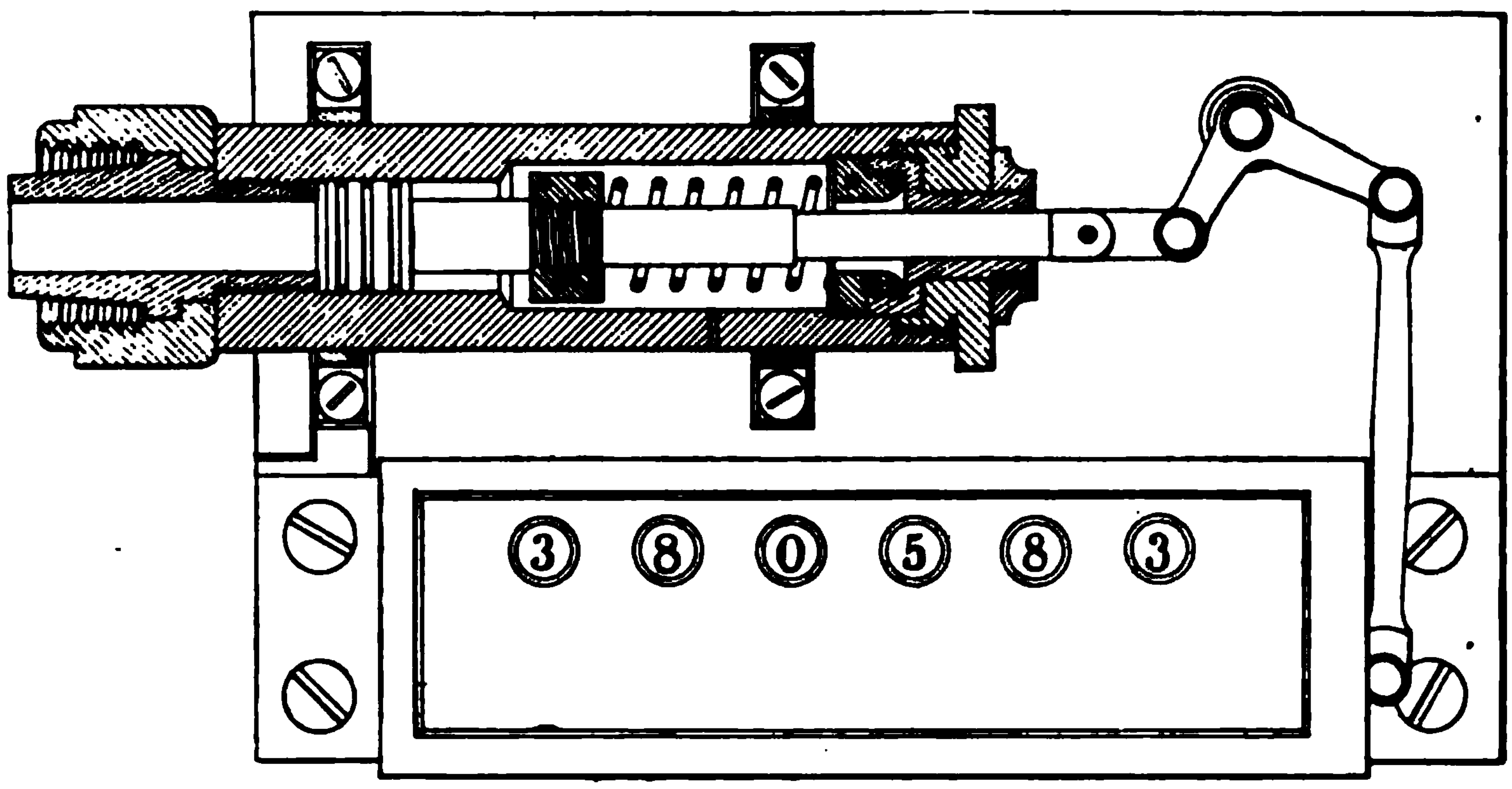
Revolutions per minute	258.3	
Explosions (total)	5624.	
" per minute	102.26	
Gas (total)	185.	cu. ft.
" used by engine, $185 - 4 \times \frac{55}{60}$	181.34	" "
" used per hour	197.	" "
" " " " per I. H. P.	22.69	
M. E. P.	67.19	lbs.
Initial Pressure, Average	302.94	" abs.
" " Highest	333.48	" "
" " Lowest	281.73	" "
I. H. P. $= \frac{13 \times 38.48 \times 102.26 \times 67.19}{12 \times 33000}$	8.68	

PRONY BRAKE H. P.

Diameter of pulley	16″	
Circumference of pulley	4.188′	
Weight on Scales, Average	283.83	lbs.
" " " Initial	45.	"
" " " Final	238.83	"
P. B. H. P. $= \frac{4.188 \times 258.3 \times 238.83}{33000}$	7.8	

From the foregoing data it will be seen, that for private houses, summer hotels and other isolated plants a gas engine is a very convenient and economical source of power for electric lighting. To obtain a light of 16 C. P., by burning the gas in the usual way, requires five cubic feet of gas per hour. Taking the cost of the gas at $1.25 per thousand feet, a 16 C. P. light would cost 0.625 cents per hour. Under a very light load the plant is more costly than by burning the gas directly ; but as the load increases the cost diminishes so that at full load it is far cheaper,

in this plant, to use the gas in an engine, to generate the electric light, than to burn the gas for light.



By using producer gas, which can be furnished at 75 cents per 1000 cubic feet, the cost is correspondingly reduced. At that rate, in Test II., instead of the cost of a lamp hour being .29 cents, it would be .17 cents.

There are a few small expenses for oil waste, etc., etc., that will somewhat increase the cost, but all conditions considered, the production of the light by a plant of this kind is more economical than the direct consumption of the gas in burners.

PLANT OF THE CATARACT-CONSTRUCTION COMPANY AT NIAGARA FALLS, NEW YORK.*

On March 31, 1886, the Legislature of New York, by a special act, granted the Niagara Falls Power Company the right to develop 450,000 horse-power. In 1889 the rights of the Niagara Falls Power Company were combined with other rights and a new corporation formed, known as the Cataract Construction Company.

The survey for the location of the tunnel and wheel-pit was begun in the latter part of March, 1890; and in August, 1891, work was begun on the canal leading from the river to the wheel-pit. The construction was carried on simultaneously; the canal being completed in 1892 and the tunnel and wheel-pit in the spring of 1894.

A power station was then erected over the wheel-pit and the hydraulic and electric apparatus put in place. The station is shown in Fig. 2. The building on the right is the main power house; the one on the left, the transformer house; and the bridge connecting them is for carrying the cables from the power house to the transformer house. The latter is not now in use.

On April 4, 1895, the machinery was set in motion.

At present the power is being used by the Pittsburgh Reduction Company, the Calcium Carbide Company, the Carborundum Company, the Niagara Falls Lighting Company and the Street Railway.

Power is delivered to consumers in any form desired. The

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* Abstract of Thesis of Messrs. E. L. Decker, O. A. Pope, and P. D. Wagoner, Class of '96

Pittsburgh Reduction Co. and the Street Railway taking it as direct current; the Calcium Carbide, Carborundum, and Niagara Falls Lighting Companies, as two-phase alternating.

The ultimate intention is to transmit power to Buffalo, and even as far as Rochester and Syracuse.

The Cataract Construction Co. also rent the privilege of using the canal and tunnel, to any company desiring to put in their own wheel-pit and wheels. The Niagara Falls Paper Co. have availed themselves of this privilege and pay the Cataract Construction Co. $48,000 per annum.

DESCRIPTION OF PLANT.

The plant will be discussed under two heads:—the hydraulic portion and the electric.

Closely allied with the hydraulic are:

1. Canal from river to wheel-pit.
2. Wheel-pit.
3. Turbines.
4. Tunnel, used as tail race for turbines.

CANAL.

The mouth of the canal is situated about 1¼ miles above the Falls, 600 feet from the shore line, and is 250 feet wide. The canal extends inwardly 1700 feet, with an average depth of 12 feet, supplying water sufficient for the development of about 100,000 horse power.

The walls are of solid masonry, 3 feet thick at the top and 8 feet at the bottom, and are 17 feet high. There are ten fore-bays running from the canal at right angles, each about 14 feet wide. They serve to admit water to the penstocks.

WHEEL-PIT.

The length of the wheel-pit is 140 ft., width 18 ft., and depth 178 ft. It is lined on the bottom with 16″ of brick and

to a height of 30 ft. with from 2 to 2½ ft. of solid brick. On the top of this brick wall is a coping of limestone 2½ ft. thick, and on this rest the girders which support the turbines and penstocks. The wheel-pit is connected by a lateral tunnel with the main one.

TURBINES.

At present there are three in place. They are outflow wheels designed by Faesch and Piccard of Geneva, Switzerland, and built by I. P. Morris & Co. of Philadelphia. Each consists of 2 turbines, one being inverted and set vertically over the other, and acting on the same vertical shaft. They are designed for 5000 H. P. but in test made developed 5484.54 H. P. Each wheel is divided into 3 sections by horizontal partitions, and the gate consists of a cylindrical band moving outside of the buckets.

There are [illegible] guides and 32 buckets. The wheel is made of bronze. The shaft is a steel tube 38 inches in diameter, except at points where it passes through the bearings, where it is solid, and 11 inches in diameter. It is [illegible] ft. long and [illegible] inch thick, and the hollow portion is rolled without any riveted vertical seams.

Nearly the entire weight of the revolving parts is supported by the upward pressure of the water in the wheel; a thrust bearing just below the first deck takes care of any excess of pressure in either direction. This bearing is cooled by water. The head at the test was [illegible] ft. [illegible] excavation though at the [illegible] the wheels are set on girders spanning the [illegible]

[illegible] inches. The [illegible] prevent jumping of [illegible] inches in the other.

[illegible] designed by Faesch and Piccard [illegible] ordinarily. [illegible] diminished by [illegible] more than [illegible]

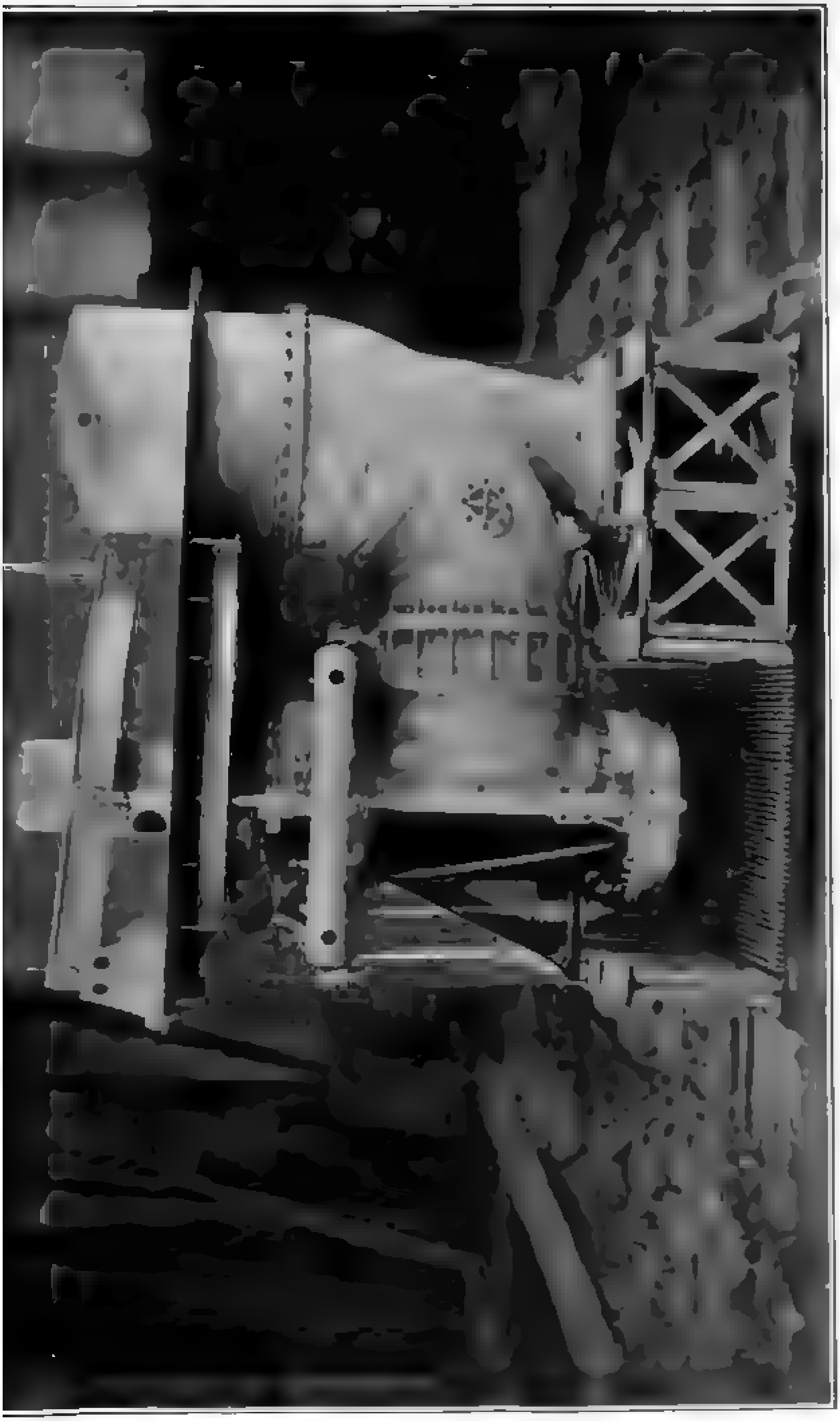

FIG. I.

[illegible] This
[illegible] exhibit
[illegible]

[illegible]

[illegible] in
[illegible] of
[illegible] 36
[illegible] argument
[illegible] action and
[illegible] ascension
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[illegible] Stewart &
[illegible] and
[illegible] white en-
[illegible] with

FIG. 2.

white enamel paint. The building is 200 feet long, and, as it may be necessary to extend it, the rear is of wood. It is supplied with a 50-ton electric traveling crane, designed by Wm. Haynes, a graduate of Stevens Institute, and manufactured by Messrs. Wm. Sellers & Co. of Philadelphia. The floor is cement throughout and there are no iron floor beams. Fig. 2 shows the building. In the centre of the building is the switch-board structure upon which are the instruments, and which will be described more in detail further on. Fig. 3 shows the switch-board structure.

GENERATORS.

The form of generator employed is that designed and constructed by the Westinghouse Electric Co., of Pittsburgh, Pa., assisted by Prof. George Forbes of London. They are 5000 horsepower each, and two-phase alternating. The height from the bottom of the bed-plate to top of floor of bridge is 11½ feet.

The armature is stationary, the field revolving about a vertical axis; this axis being bolted below first deck to the turbine shaft. The diameter is 12 15/16 inches.

The field ring is 11 feet 7⅛ inches in diameter and is fastened to the generator shaft by means of a driver to which it is bolted; this driver is 11 feet 8 inches in diameter and of mild cast steel.

The weight of entire shafting and revolving portion of generator is about 152,000 pounds.

The weight of field ring with poles attached is 70,000 pounds. There are 12 poles, each pole piece with its bobbin weighing 2800 pounds.

The pole pieces are of mild open-hearth steel. The field winding consists of copper conductors thoroughly insulated, contained in ribbed brass boxes.

Above the driver are collector rings by means of which current is conveyed to the field. These rings are separate castings and are fastened to the driver by heavy screws.

FIG. 4.

The armature support is cylindrical in form and is fastened to a bed-plate. The armature ring fits over this support and is composed of thin sheets of mild steel No. 30 B. W. G., and to aid the free circulation of air it is divided vertically into 6 equal parts separated by 1 inch of space.

The conductors consist of copper bars of $1\frac{1}{32}''$ by $\frac{7}{16}''$ section. They are insulated principally with mica. The wires used in cross connecting are insulated by mica and rubber insulating tape, and the joints are soldered by means of electricity.

The frequency is 25 cycles per second at a speed of 250 revolutions. The weight of the entire generator is 170,000 pounds.

The normal potential is about 2100 volts on each phase and amperage about 1000.

At present there are three generators installed.

Fig. 4 shows two of them, the third has since been erected.

The generators are ventilated by scoops placed in holes in the driver.

CONVERTERS.

There are two 500 kilowatt rotary transformers and four 250 kilowatt static converters.

Alternating current is taken from the bus-bars at about 2000 volts and is stopped down in the static converter to about 125 volts. This alternating current is delivered from the secondary terminals of the static converter to the rotary transformer and from the commutator end of this machine direct current at about 125 volts is directed to the field of the generators. Rheostats are interposed in the circuits to permit adjustment of field current.

A small motor is directly connected to the shaft of the rotary transformer to get it up to speed.

THE SWITCH-BOARD.

The switch-board structure is of white enameled brick, 57 ft. long by 13 ft. wide and 8 ft. high. The top of the structure is of

slate. The switch-board carries three high tension switches which are separated from each other by brick walls one inch thick.

Current indicators and three fuse carriers are also set in place.

Lightning arresters are used between the building and the first outer pole. These are of the Wurts type.

At Buffalo connection is made from cables on the poles with the underground cables. These latter are covered with rubber, sheathed with lead, the insulation to withstand 80,000 volts.

At this point the current after reduction in the static transformer is converted into a direct current by a rotary transformer and is then ready for distribution and use.

QUANTITATIVE ESTIMATION OF MICRO-ORGANISMS.

BY ALBERT R. LEEDS, PH. D.

The microscopical examination of waters is necessarily subdivided into two entirely distinct parts:—the first part concerns itself with the direct study by means of the microscope of those animals and plants which cannot be seen with the naked eye, or which, if visible at all, require the aid of the microscope for their satisfactory differentiation. These organisms are most conveniently described as micro-organisms, to distinguish them from the macro-organisms, which make up the visible aquatic life.

The second part is restricted to those exceedingly minute plant growths included under the general name of bacteria, and which cannot be satisfactorily studied with the microscope alone, inasmuch as they require cultivation in a variety of media, to develop the characteristics essential to their classification, and inasmuch as they also demand a variety of tests of a chemical character, to ascertain the nature and extent of the changes that they are capable of effecting in the various culture-media in which they are grown.

The study of the bacteria cannot be carried beyond its earlier and simpler stages, without the aid of a laboratory specially equipped for bacteriological investigation. But no engineer, whose duties as superintendent of water-works requires that he should keep himself familiar with the daily changes occurring in the waters under his management, should forego the great pleasure and advantage of familiarizing himself with the aquatic micro-organisms, and with the simple apparatus and appliances for their quantitative examination.

This is more especially important for the reason that the

tastes and odors of waters are neither adequately accounted for, or investigated, in the chemical and bacteriological part of an investigation into their quality. These tastes and odors are usually due to the micro-organic life. They are capable of being brought to such intensity, by the extremely rapid growth of the organisms which produce them, that, in a few days or even hours, the whole of a city water-supply, previously palatable and sweet, may become nauseating and unpotable. Armed with a microscope and no more apparatus than can conveniently stand on the corner of his office table, the engineer can find endless pleasure and profit in his leisure moments, in studying the exquisitely beautiful forms, the strange motions and the wonderful transformations visible in the botanical and zoological garden comprised within a drop of water. And when some ill-tasting and smelling organism appears, he is in a position to detect it and institute appropriate remedies, before popular outcry and complaint has heaped upon him and his professional work, unmerited contumely and abuse.

These considerations are of increasing weight, now that public opinion in this country has at last been educated to the point that it has long since attained in Great Britain and on the Continent ;—that water supplies, except when they are of unusual and extraordinary purity, should be filtered. Whenever a water is not clear and limpid ; whenever it is turbid and develops a sediment, it is not in a proper condition for delivery to consumers, and the microscope is an invaluable aid in revealing the nature and amount of the impurities, which filtration should be called upon to take out. Will a certain water be improved or injured by being kept in incessant circulation ? Will it be benefitted or otherwise by mechanical aeration ? Should it be exposed as much as possible to the light, or should it be kept in as nearly entire darkness as possible ? These are some of the questions whose solution is most intimately bound up with the study of the micro-

organisms that either flourish or decay, as either rest or motion; oxygen or want of oxygen; light or darkness, are the agencies best adapted to stimulate or deaden them.

Unfortunately there is an impression prevalent among engineers that to do any good work with a microscope, a costly instrument, with high-power objectives and many expensive accessories, is requisite. Just the opposite is the case.

For practical results in the study of waters, the object is not to study exhaustively the appearance and functions of plants and animals. This is the task of a specialist both in natural history and microscopy. It has already been done: the results are recorded in books, and the water chemist and engineer have only to make practically valuable the immense store of observations which have hitherto been left unutilized. The chief need is, 1st.—A rapid and easy method of collecting all or some known fractional part of the whole number of organisms in a given volume of water, upon one slide at one and the same time; 2d.—To register and estimate their kinds, their numbers and their volume.

We shall not stop to give an historical account of the earlier attempts to solve the first part of this problem. They were all more or less imperfect attempts, depending upon collecting the sediment in a tall jar or examining the deposit left by filtering the water through a sieve or cloth. The first practical method was that of Mr. A. L. Kean.* He used a funnel stopped by half an inch of sand, the sand being held back by a plug of wire gauze, and when a definite volume of water had been filtered through the sand, the plug was removed and the sand and the organisms washed down into a watch-glass. After the sand had settled the water standing above it was transferred to a cell of one cubic millimeter in volume and the number of organisms counted.

The Kean method was greatly improved by Prof. Wm. T.

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* *Engineering News*, March 30, 1889.

Sedgewick,* who used a much larger cell, its inner dimensions being 50 millimeters in length, 20 millimeters in width, and 2.5 millimeters deep. The bottom of this cell is ruled into 1000 squares each of one square millimeter in area. The sand and organisms are both washed into this cell, the sand uniformly distributed over the bottom, and then the number of organisms is ascertained by counting those visible in say 10, 20 or 50 squares, and estimating the total in the entire 1000.

The method has been still further improved by Mr. G. W. Rafter, and it is with the method in this advanced form that we have to do at present.

The first matter to be considered is the apparatus for filtration; then that for counting, and finally the method for observing and recording.

The filtering funnels are best made of cylinders 2″ in inside diameter and 10″ high, drawn down into a funnel 3″ on its side and ending in a straight funnel tube 0.5″ inside diameter and 3″ long. They are closed with a rubber stopper 1″ long, 0.5″ wide at narrow, and 1.2″ wide at broad end. The stopper has an 0.1″ perforation, which is covered on its upper side when in use with a disc 0.3″ diameter, struck out of fine bolting cloth with a common hand-punch.

These arrangements are the result of the suggestions of a number of workers, and, as illustrated in the cut, are similar to those which the experiments of Mr. D. D. Jackson have indicated to be the most satisfactory.

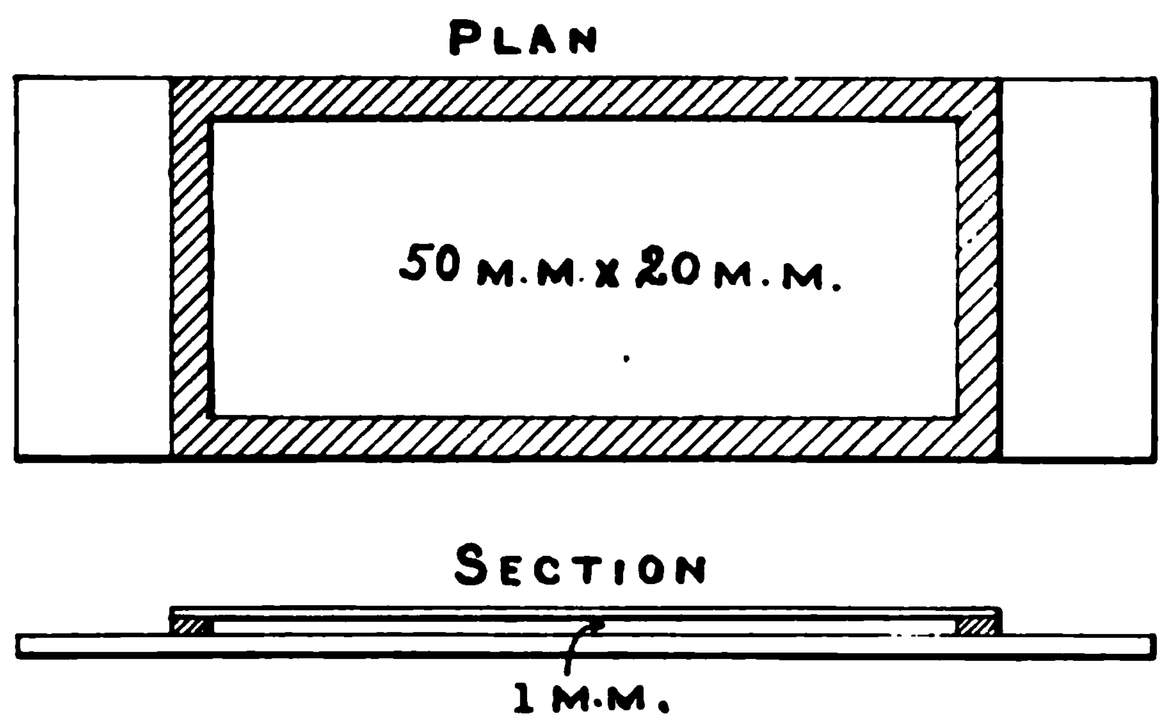
The best sand for filtering is that manufactured by the Berkshire Glass Manufacturing Co. of Cheshire, Mass. It is made of crushed quartz and is screened out by sieves, so as to take that yielded between 50 meshes to the inch and 100 meshes to the inch. Sand of this coarseness will do for the ordinary run of or-

* Recent Progress in Biological Water Analysis. *Jour. New England W. W. Assn.*, p. 50, 1889.

MICRO-ORGANISM FILTERING APPARATUS.

ganisms: in exceptional cases a little finer sand, that yielded between the 80 and 120 mesh limits, can be thrown on top of the other at the time of filtering. A depth of about ¾ of an inch of sand is sufficient; it arrests about 95 per cent. of the organisms, amorphous matter, etc.

Six or more of these filter-cylinders are supported on a rack, as seen in the drawing, with a broad shelf at the bottom, the rack figured being 26″ long, with the supports 3½″, 5″ and 6″ in width and provided with 6 battery jars 4″ diameter and 4½ deep. Sometimes a suction tube is attached to the perforated stopper of the funnel, when the filtration is slow, but this is rarely necessary or desirable.



COUNTING CELL FOR MICRO-ORGANISMS.

The counting cell is an ordinary glass cell to which is cemented a brass cell 50 millimeters long, 20 millimeters wide and 1 millimeter deep. It is covered when in use with a cover of No. 3 glass between $\frac{1}{50}$ to $\frac{1}{100}$ inch thick, and should then contain exactly one cubic centimeter.

Usually 500 c.c. of the water is filtered and after it has all run through, the stopper is carefully removed, and the end of the funnel inserted into a test tube of somewhat larger diameter. The

adherent sand is washed down with the discharge from a 5 c.c. pipette; if the organisms are very numerous, a 10 c.c. pipette is used, or if they are few, a 3 c.c. or even a 1 c.c. pipette may be employed. On shaking the sand briskly the organisms are diffused through the water, which is then briskly decanted into another test tube and the latter put aside for counting and microscopic examination.

Now with reference to the microscope equipment. The writer has employed the largest and finest of Zeiss stands with a mechanical stage, but any good solid stand with an ample stage is entirely adequate. And moreover, he has not found a special mechanical stage, with a millimeter movement for racking the cell through a fixed distance, of any material advantage in making the counting. He has simply pushed the cell from left to right and back again by hand through approximately equal intervals until the organisms in as many square millimeters have been counted, as seemed necessary to make a fair count. Then a survey has been made of the whole field, for any forms casually omitted, and a fair allowance made for them in the final estimate. In observing, the precaution should not be neglected, of racking the objective up and down, at each millimeter count, so that the forms floating up to the under side of the cover glass may not escape counting.

The only essential part of the microscope outfit for doing this particular work, is an eye-piece micrometer ruled in a square, as figured in the drawing. The outside square should be ruled into a square of such a number of millimeters on the side, usually from 5 to 7 millimeters, that with the particular objective used in counting, the sides of the square as seen in the eye-piece micrometer, should exactly subtend one millimeter as viewed on the stage micrometer when the draw-tube is drawn out to an observed number of divisions. For example, such an eye-piece micrometer used by the writer and ruled by Leitz, is 7 millimeters on

the side. When placed in the No. 3 Zeiss eye-piece (focal length 30 millimeters), and used in the Zeiss stand Ia with the Zeiss objective A (focal length 30 millimeters), it requires a tube length of 149 millimeters. The same micrometer and eye-piece with a Reichert's No. 3 objective (focal distance 18 millimeters), and with the Reichert stand No. 111 B., which is a very excellent one for doing this class of work, requires a tube length of 147 millimeters.

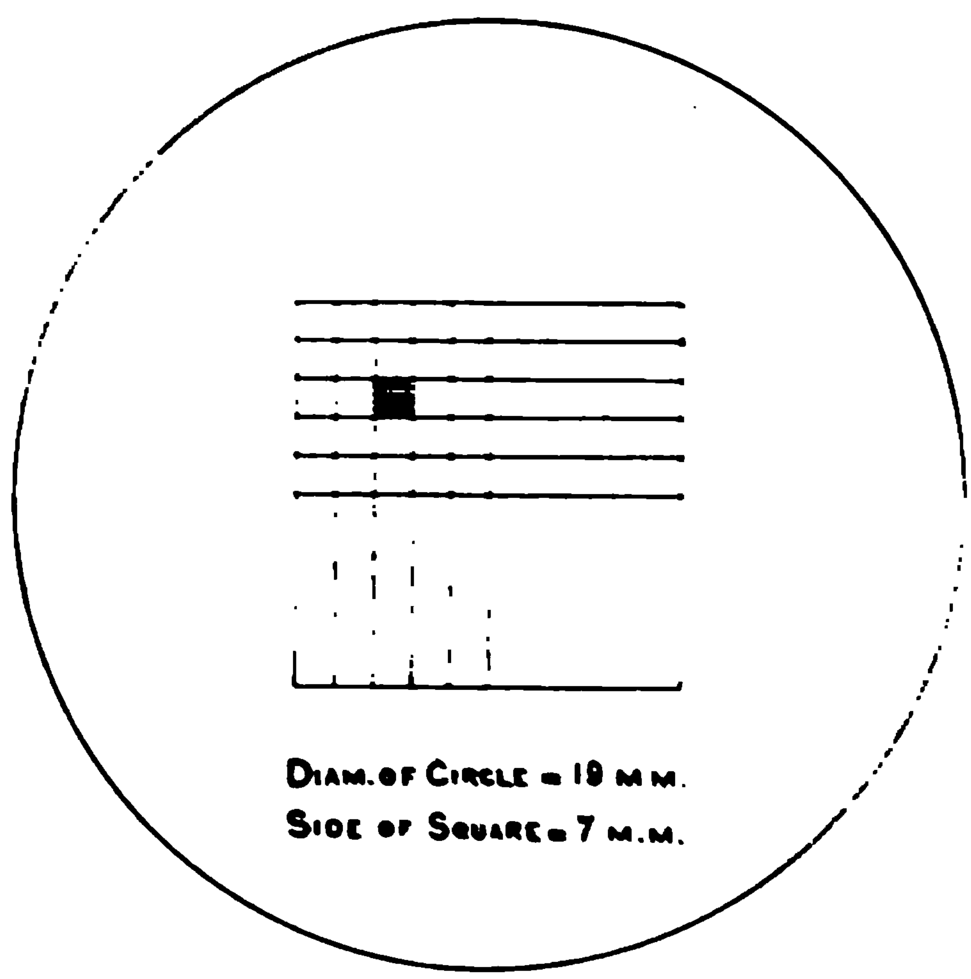
An inexpensive substitute for the ruled glass micrometer may be made by cutting out a square of the desired size in a sheet of thin copper, aluminum, platinum foil, or even tin or cardboard, and inserting this in any ordinary eye-piece.

Besides the 18 millimeter objective, with a magnification for this tube length of 70 times, it is a great convenience to have mounted at the same time, in a double nose-piece, a 10 millimeter objective having a magnification of 84, for the purpose of more minutely studying an object, apart from the counting, while it remains in the cell.

As originally proposed by Mr. Rafter, the eye-piece micrometer was ruled with one square only. This answered satisfactorily, so far as the mere counting of the number of micro-organisms is concerned. But a difficulty was encountered when an attempt was made to estimate the amount of amorphous matter. The plan recommended was for the observer to carry in his mind a sort of mental standard as to the unit of area covered by one mass of amorphous matter. But it is very evident that the actual area covered by different individuals of one species is very different, as is also the area covered by different species of the same genera. Thus a filament of Anaboena or Oscillaria may be long or short, or narrow or wide. Under the head of Navicula, there may be visible at the same time Navicula Pulchella, which is a small diatom, and Navicula Ulna, which is many times larger. So, besides the number of organisms, the area covered by them

as well as by the irregular masses of amorphous matter, becomes of much importance.

Mr. Geo. C. Whipple proposed one fixed definite unit which should be the same for all persons, and decided upon 400 square microns as a convenient value for it. It was convenient, because, to facilitate the counting, the one square on the micrometer introduced by Mr. Rafter, had been first subdivided into four one-quarter square millimeters, and then one of the four quarters into twenty-five smaller squares. The side of the smallest division is 0.1 millimeter long, or 100 microns. Now one-fifth of this dis-



AREA COUNTING UNIT.

UNIT=400 SQUARE MICRONS.

tance, which is 20 microns, is easily estimated by the eye, and the corresponding square, or 400 square microns, becomes a very convenient unit of area. This is now, and has been for a number of years, the unit used by the Boston Water Works, and, it appears to us, in every way preferable to using exactly one-quarter of the smallest divisions, or 2500 square microns, which is

[illegible] Massachusetts State Board of Health. [illegible] micro-[illegible] organisms [illegible]

[illegible] square micrometer [illegible] squares [illegible] squares [illegible]

[illegible]

[illegible]

[illegible] would [illegible] in this [illegible] and are [illegible]

MICROSCOPICAL EXAMINATION.

Sample from........................... ....Number..................
Date of Collection..... ... .. . Amount Examined........ ....Label......... ....
Date of Examination............Depth of Sample....... ....Temperature......... ....

NUMBER OF SQUARE.	1	2	3	4	5	6	7	8	9	10	Total	Number per c.c.	Units per c.c.
DIATOMACEAE.													
Asterionella													
Cyclotella													
Diatoma													
Fragilaria													
Melosira													
Navicula													
Synedra													
Tabellaria													
CHLOROPHYCEAE.													
Arthrodesmus													
Chlorococcus													
Closterium													
Cosmarium													
Pediastrum													
Protococcus													
Raphidium													
Scenedesmus													
Staurastrum													
CYANOPHYCEAE.													
Anabaena													
Chroöcoccus													
Clathrocystis													
Cœlosphaerium													
Microcystis													
Nostoc													
Oscillaria													
FUNGI.													
Crenothrix													
Moulds													
RHIZOPODA.													
Actinophrys													
Arcella													
Difflugia													
INFUSORIA.													
Dinobryon													
Mallomonas													
Monas													
Peridinium													
Synura													
Trachelomonas													
Uroglena													
ROTIFERA.													
Anuraea													
Polyarthra													
CRUSTACEA.													
Bosmina													
Cyclops													
Daphnia													
MISCELLANEOUS													
Ova													
Sponge Spicules													
Starch Grains													
Vegetable Tissue													
Zoöspores													
TOTAL													
Amorphous Matter													
NOTES								BACTERIA					

[illegible]

[illegible]

[illegible]

[illegible]

ing the indications afforded by analysis and by the microscope, if we could reduce superficial units to units of volume and weight. At present it is possible to obtain only very remote approximations to the true value of such units, but there is value in making the attempt, and the following method is suggested.

It may be assumed that the average thickness of the organisms examined is not far from 5 microns. Now 1 cubic centimeters is 1,000,000,000 cubic microns. 1 part per 100,000 would be 10,000 cubic microns in 1 cubic centimeter. Our Area Counting Unit being 400 square microns, the Volume Counting Unit, or 1 part per 100,000, would have to be $25 \times 400 = 10,000$, or the Area Counting Unit must be 25 microns in thickness to make it a Volume Counting Unit. As the organisms observed instead of 25 microns in thickness are only 5 microns, the number of Volume Counting Units they would occupy, would be only one-fifth of their Area Counting Units, or the number of superficial units per cubic centimeter divided by 5, would be approximately the number of parts by volume in 100,000.

The next step would be to pass from the volume to the weight of the micro-organisms. Their specific gravity cannot be far from that of water, inasmuch that while the tendency of the great majority is to deposit by sediment; it is a slow process and moreover, and especially with regard to vegetal forms, it is not universal, many tending to rise. But in the living organisms, both plant and animal, the chief chemical constituent is water itself, very little solid matter remaining after complete drying. If we assume that the 1/200 part of the living organism is solid matter, then the number of superficial units divided by one thousand, would give us the number of parts by weight of the solid matters of the micro-organisms in 100,000 parts of water.

In some comparisons made by the author, the result thus obtained seemed a probable one when compared with the data afforded by chemical analysis.

By way of illustration I shall select from the laboratory records the results of the microscopical examinations of the waters of New York City, Jersey City and Hoboken, collected on the same day, Dec. 5, 1896.

	New York		Jersey City		Hoboken	
	Number per c.c.	Units per c.c.	Number per c.c.	Units per c.c.	Number per c.c.	Units per c.c.
Asterionella	[illegible]	45	[illegible]	[illegible]	[illegible]	[illegible]
Cyclotella	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Diatoma	[illegible]	[illegible]				
Fragilaria					[illegible]	[illegible]
Melosira	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Navicula	[illegible]	[illegible]	[illegible]	[illegible]		
Synedra	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20
Tabellaria	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
Stephanodiscus	[illegible]	[illegible]	[illegible]	[illegible]		
Cymbella	[illegible]	[illegible]				
[illegible]			[illegible]	[illegible]		
[illegible]					[illegible]	[illegible]
[illegible]	[illegible]	[illegible]				
[illegible]		[illegible]				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
[illegible]	[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]				
[illegible]					[illegible]	[illegible]
[illegible]	[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
[illegible]					[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]				
[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]		[illegible]		[illegible]		
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PAINT ANALYSIS.

BY THOS. B. STILLMAN, PH.D.

Paint is a liquid preparation having a two-fold use. Primarily it acts as a protecting coating against the action of the weather, and simultaneously as a decorative agent.

The liquid is usually linseed oil and turpentine and the coloring matter or body some solid pigment, such as finely ground red oxide of iron.

It is essential in the production of a good paint that the oil used be one that, upon drying on the surface applied, should become hard, lustrous, and somewhat elastic.

Linseed oil excels all others in use for this purpose, and any sophistication thereto only deteriorates the quality.

Four qualities are essential in a paint: 1. Durability; 2. Working Qualities; 3. Drying Properties; 4. Covering Power.

The following list of pigments, with their chemical composition stated, will give an idea of the great variety that can be used in paints for outside work. The list would be largely increased were other pigments included that are used for interior decorative work only.

Red Pigments.—Indian red, Tuscan red (Fe_2O_3), vermilion (HgS), red lead (Pb_3O_4), antimony vermilion (Sb_2S_3). Iron oxide, Indian red, and Tuscan red can be analyzed by methods for iron ores.

Brown Pigments.—Umbers (Fe_2O_3, MnO_2, etc.), Vandyke brown (Fe_2O_3, carbon), manganese brown (Mn_3O_4) and sepia. The composition of sepia is as follows:

Melanin	78.00	per cent.
$CaCO_3$	10.40	"
$MgCO_3$	7.00	"
Alkaline sulphates	2.16	"
Organic mucus	1.84	"
	99.40	"

White Pigments.—White lead [illegible] PbH_2O_2 [illegible], lead sulphate [illegible], zinc white [illegible], sulphide of zinc white, ZnS [illegible]. [illegible] filler: [illegible] BaS [illegible] barytes, gypsum [illegible] white [illegible] whiting [illegible] $CaCO_3$ [illegible], China [illegible] and magnesia MgO.

Yellow and Orange Pigments.—Chrome yellow [illegible], Chinese yellow [illegible], zinc chrome $ZnCrO_4$ [illegible], cadmium yellow [illegible], yellow ochre [illegible], Siennas [illegible] H_2O, MnO_2 [illegible].

Green Pigments.—Chrome green [illegible], copper green [illegible], mineral green [illegible] green, Zn [illegible] O_3 [illegible], manganese green [illegible] Mn [illegible], emerald green [illegible] green [illegible] and Brunswick green compounded of [illegible] chrome yellow, Prussian blue, etc.

Black Pigments.—Lampblack [illegible] bone-black [illegible] carbon and [illegible], vegetable black [illegible] black, coal tar black, asphaltum [illegible] graphite black [illegible].

Blue Pigments.—Ultramarine [illegible] Na [illegible] S [illegible], Prussian blue, Chinese blue or Brunswick blue [illegible], cobalt blue or smalt [illegible], Bremen blue [illegible], and copper blue [illegible].

[illegible] have [illegible] Engineering Chemistry. These [illegible]

[illegible] Pat. 1. [illegible] states: [illegible] forms a coat that [illegible] resistance to the action of acids and alkalies has [illegible] that the conditions of service, and [illegible] moisture [illegible] satisfactory. Heat [illegible] hammers [illegible] with a [illegible] the paint has been used [illegible] hammers, and there seems to be no [illegible] been.

SCHEME FOR THE ANALYSIS OF WHITE PAINT GROUND IN OIL,

It may contain silica, barium sulphate, lead sulphate, calcium sulphate, lead carbonate, clay, zinc oxide and sulphide,* barium carbonate, calcium carbonate, linseed oil, rosin oil,† and mineral oil.

Select a thin glass flask (150 cc.), weigh it and transfer to it about 6 grams of the paint and reweigh. (Many chemists prefer to use the Soxhlet-tube with ether for extraction of the oil. Fig. 1 shows one form of this apparatus). Add 50 cc. sulphuric ether, or petroleum ether, warm slightly, cork the flask, set aside two hours. Pour the clear ether solution upon a filter, and collect filtrate in a weighed beaker. Repeat this operation until the last ether extract is colorless. Transfer residue to filter and wash with ether.

1. Residue may contain $PbSO_4$, $2PbCO_3PbH_2O_2$, $BaSO_4$, $CaSO_4$, $CaCO_3$, $BaCO_3$, ZnO, SiO_2, Clay, $ZnCO_3$, etc. Dry this residue and treat with hot acetic acid in a No. 2 beaker. Dilute with water, warm, and filter.

3. Residue may contain SiO_2, Clay, $PbSO_4$, $CaSO_4$, $BaSO_4$. Transfer the filter and contents to a small flask and digest, in the cold, for 12 hours with a saturated solution of $(NH_4)_2CO_3$. Filter, wash well with water. Neglect the filtrate. The residue on the filter is now treated with hot acetic acid: filter, wash well.

5. Residue may contain $BaSO_4$, SiO_2, or Clay. Dry, ignite in platinum crucible and fuse with Na_2CO_3; cool, dissolve in water, transfer solution to a 3-inch porcelain dish, add 25 cc. HCl, and evaporate to dryness Take up with water and HCl. Filter, wash well.

7. Residue.—Dry, ignite, and weigh as SO_2. (Silica.)

8. Filtrate.—Make alkaline with NH_4OH; boil, filter, wash well.

Residue:—Dry, ignite, and weigh as Al_2O_3 and calculate as $SiO_2Al_2O_3$ Clay.

Filtrate:—Make acid with HCl, add dilute H_2SO_4, filter, wash, dry, ignite, and weigh as $BaSO_4$.

6. Filtrate, may contain $2PbC_2H_3O_2$, $Ca(C_2H_3O_2)_2$ sat'rate with H_2S gas, filter.

9. Residue, contains PbS. Dry, transfer to a weighed porcelain crucible, add HNO_3, evaporate with H_2SO_4, dry, ignite, and weigh as $PbSO_4$.

10. Filtrate, contains CaO. Boil out the H_2S, add NH_4OH, then $(NH_4)_2C_2O_4$, set aside two hours, filter, dry, ignite, and weigh as CaO, and calculate to $CaSO_4$.

4. Filtrate, may contain zinc, lead, barium, and calcium salts. Saturate with H_2S and filter, wash with H_2S water.

11. Residue.—PbS and ZnS. Dissolve in HNO_3, add H_2SO_4, evaporate nearly to dryness, cool, add water, filter, wash well.

13. Residue.—Dry, ignite, and weigh as $PbSO_4$ and calculate to $2PbCO_3$ PbH_2O_2. ("Basic lead carbonate.")‡

14. Filtrate.—Make alkaline with Na_2CO_3, boil, filter off the $ZnCO_3$, wash, dry, ignite, and weigh as ZnO. If H_2S has been indicated by qualitative analysis, calculate to ZnO, ZnS.

12. Filtrate.—Boil out H_2S, add HCl, and dilute H_2SO_4, to precipitate the barium. Filter, wash.

15. Residue.—Dry, ignite, and weigh as $BaSO_4$, and calculate to $BaCO_3$.

16. Filtrate. Add NH_4OH to alkaline reaction, then $(NH_4)_2C_2O_4$; set aside two hours, filter, wash, dry, ignite, and weigh as CaO and calculate to $CaCO_3$.

Silica.	Clay.	$BaSO_4$.	$PbSO_4$.	$CaSO_4$.	$2PbCO_3$ PbH_2O_2.	ZnO, ZnS.	$BaCO_3$.	$CaCO_3$.

2. Filtrate, contains the oils. Evaporate carefully to expel the ether and determine the weight of the oil.

If qualitative analysis has shown the presence of mineral oil, in addition to the linseed oil, proceed as follows:

Take 20 grams of the paint, exhaust with ether, and so obtain enough oil for saponification, etc.

After expulsion of the ether, add 200 cc. of an alcoholic solution of potash and evaporate until all the alcohol is expelled. Add 100 cc. water, dissolve any soap formed, and transfer all to a separatory funnel, add 50 cc. of sulphuric ether, shake well, and set aside twelve hours. The linseed oil, as soap, is drawn off in the water solution, while the mineral oil remains unsaponified in the ether.

Transfer this latter to a glass evaporating dish, expel the ether, and determine weight of mineral oil. This weight, subtracted from total weight of the two oils taken gives the weight of the linseed oil.

Linseed oil.	Mineral oil.

* Zinc White is usually a mixture of ZnO and ZnS. "Lithophone," a zinc white, contains: barium sulphate, 67 per cent.; zinc oxide, 8 per cent.; zinc sulphide, 25 per cent.

† Rosin oil is best determined in a mixture of saponifiable and non saponifiable oils, by the method of Twitchell. Consult *Journal of Analytical Chemistry*, 5, 379.

‡ For comparison of the different methods for determining the carbonic acid in paints, consult "The Determination of Carbonic Acid in White Lead," by F. C. A. Meisel, *The School of Mines Quarterly*, 14, 318.

FIG. 1.

methods of manufacture and assay can be advantageously studied by reference to "Painters' Colors, Oils, and Varnishes," by George H. Hurst, F.C.S., London, 1892, pp. 249–282.

The analysis of a white paint, ground in oil, as shown in the Scheme on page 47 will indicate the method of procedure in analyses of this character. Where qualitative analysis has shown the presence of a few constituents only the Scheme can be correspondingly modified.

ANALYSIS OF WHITE LEAD PAINTS *

(Dry, not ground in oil.)

	1.	2.	3.	4.	5.	6.
PbO........	86.35	85.93	83.77	84.42	86.5	86.24
CO_2..	10.44	11.89	15.06	14.45	11.3	11.68
H_2O........	2.95	2.01	1.01	1.36	2.2	1.61
Total.....	99.74	99.83	99.84	100.23	100.0	99.53

from which the composition of the white leads can be calculated to be :

	1.	2.	3.	4.	5.	6.
$PbCO_3$......	63.35	72.15	91.21	87.42	68.36	70.87
PbH_2O_2....	36.14	27.68	8.21	12.33	31.64	28.66
Moisture...	0.25	....	0.42	0.48	....	....
Total.....	99.74	99.83	99.84	100.23	100.00	99.53

No. 1. English make. Made by Dutch process ; of very good quality.
No. 2. " " " " " " " " " "
No. 3. Krems white. Made by precipitation with carbon dioxide. It is deficient in body, although of good color.
No. 4. German make. Precipitated by carbon dioxide; of good color, but deficient in body.
No. 5. German make. Made by Dutch process ; a good white.
No. 6. German make. Made by precipitation of carbon dioxide ; quality fair.

Lead white, ground in oil, is a common form in the market. It usually contains about eight per cent. of raw linseed oil, and has an extended use among painters, as it readily mixes with additional oil and turpentine to form liquid paint.

* Painters Colors, Oils and Varnishes. By G. H. Hurst, F. C. S., p. 39.

[illegible]

[illegible] while longer [illegible]

[illegible] will be found in so-

[illegible] difficulty will be ex-

[illegible] be-

[illegible] each chrome

[illegible] PhD.

SCHEME FOR THE ANALYSIS OF MIXED CHROMATE AND SULPHATE OF LEAD (LEMON CHROME*) NOT GROUND IN THE OIL.

Pulverize the sample, pass through a 100-mesh sieve, and mix. To one gram in a small beaker, add hydrochloric acid and heat. Any insoluble matter (usually barytes as a gross adulteration) is to be filtered out, washed, ignited and weighed.

Lead.—One gram is treated in a covered casserole with twenty-five cc. concentrated sulphuric acid and heated moderately until the residue is perfectly white; cool, dilute with fifty cc. water and again cool; add fifty to seventy-five cc. of ninety-four per cent. alcohol, stir, and allow to stand one hour. Filter, wash well with alcohol.

Chromium and sulphuric acid (SO_3).—Treat one gram with about twenty-five cc. concentrated hydrochloric acid, boil, dilute to 100 cc. and while hot add excess of ammonium hydroxide, which precipitates the chromium and the greater part of the lead. Boil off the excess of ammonia, filter and wash *carefully* with hot water.

1. **Precipitate for Cr.**—Dissolve in dilute HCl, neutralize excess of acid with NH_4OH, precipitate Pb with H_2S gas and filter into a *porcelain dish*.

3. **Precipitate.**—PbS, reject.

4. **Filtrate.**—Boil off every trace of H_2S and precipitate Cr with NH_4OH in the usual manner. Put the moist precipitate and filter paper into a crucible and ignite carefully. Weigh as Cr_2O_3.

2. **Filtrate for SO_3.**—Acidify with HCl, concentrate, add boiling solution of $BaCl_2$ drop by drop and determine SO_3 as usual.

* Analysis of Chrome Paints. By W. L. Brown, *J. Anal. Chem.*, 1, 213-215.

ANALYSIS OF CHROME GREEN.

(Composed of Yellow Chromate of Lead, Prussian Blue and Lead Sulphate.)

To one gram of sample add twenty-five cc. HCl, heat to boiling several minutes, add water, allow to stand ten minutes, then filter and wash thoroughly with hot water.

1. **Residue.** — Prussian blue (plus barytes or other insoluble matter if present). Dry and ignite to Fe_2O_3. Weight multiplied by 2.21 equals per cent. Prussian blue.

2. **Filtrate.**—Nearly neutralize with NH_4OH, leaving, however, the solution slightly acid. Pass H_2S gas through till Pb is all precipitated. Filter and wash.

3. **Precipitate,** PbS.—Dissolve on filter with hot dilute HNO_3 and boil the solution. Filter from collected S and bring filtrate of $Pb(NO_3)_2$ to small bulk, with several additions of H_2SO_4. Evaporate to fumes of SO_3, cool, add water and alcohol, filter, wash and weigh as $PbSO_4$.

4. **Filtrate.** — For Cr (and Fe), boil off H_2S, add NH_4OH, in slight excess, boil this off and wash the $Cr_2(OH)_6$ (and $Fe_2(OH)_6$), as customary. Weigh precipitate as $Cr_2O_3+Fe_2O_3$. After the weight is obtained, mix with one part KNO_3 and three parts Na_2CO_3; fuse in platinum crucible to clear fusion, cool, boil with water, filter and wash.

5. **Residue.** — Filter, wash, dry, and weigh as Fe_2O_3, if it is wanted as a check.

6. **Filtrate,** for Cr.—Precipitate with NH_4OH in glazed porcelain dish. If the weight of Cr_2O_3 is *very nearly* the same as before, then there has been no Fe extracted from the Prussian blue by the acid treatment. Some varieties are affected by this, others not. If the weight is less than the original, deduct it from same. The result is Fe_2O_3, which is also to be calculated to Prussian blue and added to the other.

comes very easy. Add twenty-five cc. concentrated sulphuric acid, evaporate to white fumes and complete the analysis as described. For chromium and sulphur trioxide determinations, boil off alcohol and proceed as previously directed.

Chrome greens, in which the coloring matter is Cr_2O_3, is seldom found in the market pure. Usually it contains from twenty per cent. to seventy-five per cent. of barium sulphate.

As an example of a specification for a compound of chrome paint, the following is given :

PENNSYLVANIA RAILROAD COMPANY. MOTIVE POWER DEPARTMENT.

Specifications for Cabin Car Color.

The standard cabin car color is the pigment known as scarlet lead chromate. It is always purchased dry. The material desired under this specification is the basic chromate of lead ($PbCrO_4PbO$), rendered brilliant by treatment with sulphuric acid and as free as possible from all other substances.

The theoretical composition of basic lead chromate is nearly 59.2 per cent. of the normal lead chromate, and 40.8 per cent. of lead oxide, but in the commercial article it is found that a portion of the sulphuric acid added to brighten the color remains in combination apparently with the normal lead chromate, slightly increasing the percentage of this constituent.

Samples showing standard shade will be furnished on application, and shipments must not be less brilliant than sample. The comparison of sample from shipment with the standard shade, may be made either dry or by mixing both samples with oil.

Shipments of cabin car color will not be accepted which

1. Contain barytes or any other adulterant.
2. Show on analysis less than fifty-seven per cent. or more than sixty per cent. of normal lead chromate, including the sulphuric acid combined as above stated.
3. Show on analysis less than thirty-eight per cent. or more than forty-two per cent. lead oxide, in addition to the lead oxide in the normal lead chromate.
4. Vary from standard shade.

Office of Gen. Supt. of Motive Power, Altoona, Pa., Feb. 18, 1891.

The various red paints, Indian red, Tuscan red, and other iron oxides, etc., used in general practice are rarely pure, but contain added amounts of finely pulverized gypsum and calcium carbonate. These oxides, when properly ground and mixed with linseed oil, form paints that cannot be excelled for durability,

[illegible]

[illegible] The [illegible]

[illegible] The sample [illegible] parallel vertical.

and it is sufficient if the oil and pigment do not separate for an inch down from the top of the test.

Shipments will not be accepted which

1. Contain less than twenty-three per cent. or more than twenty-seven per cent. of oil.

2. Contain more than two per cent. of volatile matter, the oil being dried at 250° F., and the pigment dried in air not saturated with moisture at from 60° to 90° F.

3. Contain impure or boiled linseed oil.

4. Contain in the pigment calcium sulphate not fully hydrated, less than forty per cent. of sesquioxide of iron, less than two per cent. or more than five per cent. calcium carbonate, or have present any barytes, aniline colors, lakes, or any other organic coloring matter, or any caustic substances, or any makeweight or inert material which is less opaque than calcium sulphate.

5. Varying from shade.

6. Are not ground finely enough.

7. Are a "liver" or so stiff when received that they will not readily mix for spreading.

Altoona, Pa., Office Supt. Motive Power.

As an example of the composition of a paint for iron surfaces (Class 2) the following mixture as used for painting the structure of the elevated railroads in New York City is given:

Boiled linseed oil	9	parts.
Turpentine	1	"
Red oxide of iron finely ground	7½	"

In mixing paints for iron surfaces, it is of the first impor tance that the best materials only be used. Linseed oil is the best medium, when free from admixture with much turpentine.

The large percentage of linolein formed in drying, makes the surface of the paint solid and of a resinous appearance, possessing toughness and elasticity. Linseed oil does not crack or blister, by reason of the expansion and contraction of the iron with variation of temperature. Another important characteristic is its expansion while drying, which adapts it to iron surfaces. The Metropolitan Elevated Railway Company experimented very

* On the Construction of the Second Avenue Line of the Metropolitan Elevated Railway of New York. By G. Thomas Hall, C. E., *Trans. Am. Soc. Civil Eng.*, 10, 130.

thoroughly with the various kinds and colors of paints; their labors at last culminated in the selection of a metallic paint for the first coat (formula given above) and a white lead paint for the second and last coat, both paints to contain the best linseed oil and enough turpentine to make the paints cover well and facilitate their drying.

The formula of the white lead paint as used is here given:

WHITE LEAD PAINT. OLIVE COLOR.

147.42	kilograms	white lead.
79.38	"	" lime ($CaSO_4$).
34.02	"	French ochre.
1.36	"	Prussian blue.
0.45	"	burnt umber.
79.50	liters	boiled linseed oil.
5.67	"	turpentine.
3.79	"	liquid drier (boiled linseed oil and lead oxide).

Some engineers prefer red lead instead of iron oxide as the pigment for paints to be used for iron structures.

G. Bouscaren, C.E., states with regard to the painting of bridges, that having used both varieties of paint, he gives preference to the red lead.*

The red lead paint adheres better to the iron and fails principally by wear and a gradual transformation of the red lead into carbonate, whilst the iron paint fails by scaling.

ASPHALT PAINT.

Until within quite recent years little has been known in this country of the valuable properties of the asphalt. In the popular mind it is often confused with certain coal-tar products, which, though similar in appearance, differ essentially from asphalt in character. Asphalt oils are of a nearly non-volatile nature, and are therefore permanent, while on the other hand, coal-tar is volatile.

* *Trans. Amer. Soc. Civil Engineers*, 15, 429.

The so-called asphalt paints which have been used in the past are such only in name. They contain, at best, but a very small per cent. of asphalt, which is incorporated in the form of a pigment and which serves no valuable purpose. Asphalt, on the contrary, should be the main constituent, since the value of such a paint depends upon the presence of the permanent asphalt oils.*

FIRE-PROOF PAINTS, SILICATE PAINTS, ASBESTOS PAINTS, ETC.

The principle of action of these paints is not to render wood work or similar material fire-proof, but to retard combustion.

Wood treated with a solution of zinc chloride, or with a solution of sodium silicate, can be rendered nearly non-inflammable, and after such treatment and drying, paint can be applied.

Instead of using the ordinary paints for this purpose, various compounds are incorporated in the paint itself to render the latter non-inflammable. Thus the preparation of Prof. Abel J. Martin, of Paris, is as follows:

Boracic acid, borax, soluble cream of tartar, ammonium sulphate, potassium oxalate, and glycerine mixed with glue and incorporated with a paint. It is the result obtained after long experiments in response to a prize of 1000 francs, offered by the Society for the Advancement of National Industry of France. A committee consisting of Professors Dumas, Palaird and Troost, after testing the materials, consisting of painted woods and various fabrics, for seven months, reported in favor of this preparation. The municipality of Paris made its use obligatory in all of the theatres there and it has stood the test of the last six years.

BLUE PIGMENTS.

Ultramarine being a silicate, can be analyzed by fusion method for silicates. This applies also to cobalt blue.

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* *Am. Eng. and R. R. Journal*, 65, 185.

COMPOSITION OF [illegible]

SiO_2	[illegible] per cent
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Total	[illegible]

COMPOSITION OF [illegible]

[illegible]	[illegible] per cent
[illegible]	[illegible]
[illegible] + SiO_2	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Total	[illegible]

COMPOSITION OF [illegible]

SiO_2	[illegible] per cent
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Total	[illegible]

EXAMINATION OF THE OIL AFTER EXTRACTION FROM THE PAINT.

The only adulterants used in linseed oil in this connection are mineral oil and rosin oil.

Turpentine, when present, is not an adulterant, and a mixture extracted from a paint may contain linseed oil, mineral oil, rosin oil, turpentine, and rosin spirit.* The latter is quite distinct from rosin oil, and when properly prepared is a perfect substitute for turpentine. If the liquid extracted from the paint is a mixture of linseed oil, turpentine, and rosin spirit the determination of the amounts of each is somewhat difficult.

Turpentine can be distinguished and determined in the presence of rosin spirit by the action of the former on polarized light, rosin spirit being inert, thus: The specific rotation of American

* Rosin spirit has an extended use in the preparation of varnishes: the use of it in paints, however, is very limited.

turpentine varies between + 8.8 to + 21.5. The bromine absorption is also an indication.

The bromine absorption of turpentine varies between 203 to 236.

The bromine absorption of rosin spirit varies between 184 to 203.

The determination of the amounts of petroleum naphtha and turpentine in a mixture can be made by the method of H. E. Armstrong, *J. Soc. Chem. Ind.*, 1, 480; consult also Allen, Com. Org. Anal., 2, 48–50.

References: "How to Design a Paint." By C. B. Dudley, *Railway and Eng. J.*, **65**, 174, 318.

"On the Analysis of White Paint." By G. W. Thompson, *J. Soc. Chem. Ind.*, **15**, 432.

"Detection of Rosin and Rosin Oil in Oils and Varnishes." By F. Ulzer, *Ibid.*, **15**, 382.

"Technical Analysis of Asphaltum." By L. A. Linton, *J. Am. Chem. Soc.*, **16**, 809.

"Rustless Coatings for Iron and Steel, Galvanizing, Electro-Chemical Treatment, Painting and Other Preservative Methods." By M. P. Wood, *Trans. Am. Soc. Mech. Eng.*, **16**, 1895, 350,-450.

"Preservative Coatings for Iron Work." By A. H. Sabin and A. O. Powell, *Engineering News*, Feb. 5, 1895, p. 86.

"Chemische Operationen der Analyse von Farbstoffen." By F. Schmidt, Mitth. Malerei, **9**, 121.

"Chemistry of Paints and Painting." By A. H. Church. London, 1892.

"Pigments, Paints and Painting." By G. Terry. London, 1893.

THE 25TH ANNIVERSARY OF THE STEVENS INSTITUTE OF TECHNOLOGY.

Arrangements for the celebration of the 25th Anniversary of the Institute are receiving all due attention by the anniversary committee.

In a circular issued Dec. 7th, 1896, the committee announced the date of the festivities as Feb. 18th and 19th, 1897, and that the celebration will consist of a grand banquet at the Waldorf Hotel, New York City, Thursday evening, Feb. 18th, followed on Feb. 19th by an Inspection of and Exhibition at the Institute.

In the afternoon of this day Mrs. E. A. Stevens will give a reception, at Castle Point, to the Trustees, Faculty, Alumni, Undergraduates, and Ladies.

In the evening of the same day a promenade concert will be given at the German Club Hall, on which occasion the musical clubs of the undergraduates will assist.

THE DINNER COMMITTEE is making strenuous efforts for the success of the banquet, which is to be a prominent feature of the celebration.

Distinguished guests will be present and make addresses.

It has been proposed that the graduates attending the banquet be seated by classes. This plan will probably be carried out if the committee is informed promptly of the number of each class that will attend.

THE INSTITUTE INSPECTION AND EXHIBITION COMMITTEE announces that the success of the exhibition of the work of the alumni is assured as it has already received promises of exhibits from many of the graduates, among whom may be mentioned:

E. A. Uehling, '77, pneumatic pyrometer for blast furnaces and the like.

L. H. Nash, '77, gas engine electric lighting plant.

J. T. Kelly, '78, induction electric generator.

Geo. M. Bond, '80, standard measuring machine.

W. H. Bristol, '84, recording instruments for pressure, temperature and electricity.

F. E. Jackson, '86, X ray apparatus.

W. E. Quimby, '87, screw pump.

This exhibition, as was announced in circular issued by the anniversary committee, will consist of machinery, specimens, models, photographs, drawings, etc., which will represent the work of Stevens graduates and testify to the prominent part they have taken in the development of engineering science.

With this information there was also sent a blank form upon which graduates were requested to enter the exhibits they intended to make.

These exhibits were classified under the following heads:

1. Machinery, invented, designed or developed.

2. Sectional models and illustrative apparatus of principles involved in machines exhibited or invented.

3. Specimens of articles produced by original and specially designed machinery.

4. Photographs of engineering constructions, machinery, etc., designed, superintended or erected.

5. Designs, plans, sketches, drawings, etc.

Exhibitors were also requested to state the amount of floor and wall space their exhibits would require and also the facilities needed. Under the latter head the following particulars were asked for:

"Fill out in detail, giving full particulars, in order that there may be no delay in fitting up for any special requirements. Also state whether you will personally, or by a representative, be able to attend to the reception and installation of your exhibit. If unable to attend to this important part personally, do you authorize the Committee to take entire charge of your exhibit at your expense?"

And finally exhibitors were requested to state what part of their exhibits they would donate to the permanent exhibition of the Institute.

A special circular issued by the Exhibition Committee gives the following information to exhibitors:

Since the time intervening before February 19 is comparatively limited, it is important that prompt decision be made to enter an exhibit, thus allowing sufficient time for its preparation, transportation, and proper installation at the Institute.

It is proposed to utilize the available space of the Library, Physical and Electrical Laboratories, the Dynamo Room and Machine Shop for the display.

It is desired that every exhibitor may be in attendance, or at least may

have a representative present on February 19, to explain and describe the interesting features of his exhibit.

In cases where any mechanical device is shown in its practical operative form, it would be a valuable addition to have sectional models or simple apparatus illustrative of the fundamental principles involved in the commercial form of the machines.

It is the intention of the Literary Committee to incorporate illustrated descriptions of the various exhibits in the souvenir publication, thus offering an extra inducement to all to be represented.

As previously suggested, the Committee anticipate that in many instances the alumni will be able to make donations to the Institute of such portions of their exhibits as would form the nucleus for a valuable and interesting permanent exhibition, which collection could be added to from time to time, and suitable provision could be planned for its reception in the proposed Alumni Building.

To facilitate the business management of the Exhibition, the Committee have adopted the following:

RULES AND REGULATIONS OF THE STEVENS INSTITUTE ALUMNI EXHIBITION.

Rule 1.—All packages containing exhibits intended for the Exhibition should be addressed to the "Exhibition Committee," Stevens Institute of Technology, Hoboken, N. J., and in addition, the name and address of the exhibitor should be written on the outside of each package.

Rule 2.—Freight and express must be prepaid.

Rule 3.—The Institute will supply gratuitously space for exhibit, power, electricity, water, steam, gas, etc., as may be required by exhibitors for the presentation of their apparatus to the best advantage and in actual operation, where possible.

Rule 4.—Expenses of cartage, unpacking, installing the exhibits and their removal at the close of the exhibition, shall be paid by the exhibitor.

The Committee will furnish all possible assistance to exhibitors, and will in instances where they are unable personally or by a representative to attend to installing their exhibits, assume charge of receiving, unpacking and arranging, as well as repacking and returning at close of exhibition, having the work performed at as small expense as possible to the exhibitor.

To assist each alumnus in planning his exhibit, the Committee have inclosed a blank form of letter, to be filled out as completely as possible and returned at earliest convenience to the Exhibition Committee.

THE COMMITTEE ON PUBLICATIONS proposes to bring out a volume of about 400 pages and otherwise of the dimensions of the Institute Catalogues, handsomely bound in cloth and very fully illustrated. This will contain in addition to full accounts of the proceedings at the Anniversary celebrations, an extended and fully illustrated history of the Institute, and also one of its founder,

Edwin A. Stevens, and his immediate predecessors. It will likewise contain as a prominent feature a record, likewise illustrated, of the work done by the Faculty and Alumni of the Institute during the 25 years which have passed since 1871.

In order that the Alumni, on whose aid in supplying material for this record and its illustration the success and completeness of this part of the work will largely depend, may have a clear idea of what it is proposed to do in this connection, a few sample pages have been prepared from such material as chanced to be most accessible and these will be found at the end of the present number of the INDICATOR.

In cases where Alumni can furnish electrotypes illustrating their work, and will loan them for a short time, this will make the work of illustration the easiest. If this cannot be done, then the next best thing will be good prints on paper from woodcuts; after this drawings and photographs. The Committee do not expect, as a rule, to use directly the electrotypes sent them, but to work up from them reduced copies in an artistic style, in the manner of the transmitting dynamometer and gas engine shown on the sample pages.

This has been done by making a print from the woodcut or electrotype on drawing paper, working this up artistically with the brush and then making a half-tone plate from the thus-modified wood-cut picture.

In sending material for illustration, graduates are requested to have in view the artistic character and fitness for reproduction with good effect, of the pictures or illustrations sent.

In some cases, of course, the plates sent may be suitable for direct use, as in the illustration of the wire-rope tramway now given, but the Committee do not expect to depend upon this. A great point will be that alumni should send this material for illustration and memoranda of their professional work, etc., as promptly as possible, for though, of course, the memorial volume cannot appear until after the celebration, it is desirable to get it out as soon after as may be.

THE PROMENADE CONCERT COMMITTEE announces that the Glee Banjo and Mandolin Clubs, composed of undergraduates, will give a concert in the large hall of the German Club, on Fri-

day evening, beginning about half-past eight o'clock and lasting an hour or so. After this there will be promenade and dance music, and light refreshments will be served. All those who take part in the anniversary celebration are expected to come to this promenade concert without special invitation.

The general committee and the sub-committees appointed to make the arrangements for the celebration, are constituted as follows:

THE COMMITTEE.

Acting for Trustees and Faculty.

President Henry Morton, Chairman. Alex. C. Humphreys, '81, Frank E. Idell, '77.

For the Alumni.

R. M. Dixon, '81, Treasurer. J. W. Lieb, Jr., '80.
A. R. Wolff, '76. Joseph Wetzler, '82,
A. Riesenberger, '76. W. H. Bristol, '84.
J. H. Cuntz, '87.

For the Undergraduates.

Walter Kidde, '97, Secretary. E. C. Grelle, '98.
Alex. B. Macbeth, '97. A. F. Westerfield, '99.

BANQUET COMMITTEE.

President Henry Morton. Alex. C. Humphreys,
A. R. Wolff.

INSTITUTE INSPECTION AND EXHIBITION COMMITTEE.

W. H. Bristol, Walter Kidde,
E. C. Grelle.

PROMENADE CONCERT COMMITTEE.

J. H. Cuntz, Frank E. Idell,
A. B. Macbeth.

PRESS COMMITTEE.

J. W. Lieb, Jr., Joseph Wetzler.

LITERARY COMMITTEE.

President Henry Morton, J. H. Cuntz,
A. Riesenberger. Rudolph V. Rose, '97.

WAYS AND MEANS COMMITTEE.

President Henry Morton, Alex. C. Humphreys,
R. M. Dixon, Walter Kidde.

INSTITUTE NOTES.

ANNIVERSARY NOTES. An interesting meeting of the Anniversary Committee was held Nov. 13, 1896, at President Morton's home.

President Morton was in the chair and the roll-call of the secretary showed the following members present:

Alex. C. Humphreys, '81, F. E. Idell, '77, R. M. Dixon, '81, A. R. Wolff, '76, Wm. H. Bristol, '84, J. H. Cuntz, '87, Walter Kidde, '97, Alex. B. Macbeth, '97, E. C. Grelle, '98.

J. W. Lieb, Jr., '80, and Joseph Wetzler, '82, sent regrets for not being able to attend.

The important business of the meeting was the selection of the date of the celebration and the appointment of the various sub-committees who were to assume the management of particular features of the celebration. The action of the committee on these matters is given elsewhere in this issue.

The Banquet Committee was appointed, with power to make all arrangements, and with instructions to secure guests and speakers for the dinner.

Prof. A. Riesenberger was upon motion requested to join the general committee.

President Morton then placed in the hands of the Literary Committee the sum of $100—which amount he generously donated for prizes to be awarded for contributions to the souvenir book.

Mr. Dixon, treasurer, reported the receipt of 117 contributions in response to the first notice sent by the committee to all graduates.

It was also upon motion decided that all subscribers be entitled to a souvenir book. Mr. Humphreys suggested that in the next notice a reminder as to voluntary subscriptions be made.

At the close of the meeting the committee repaired to President Morton's dining-room where they were very pleasantly entertained.

BY INVITATION OF President Morton, the December meeting of the American Chemical Society, New York Section, was held at the Institute on Friday evening, Dec. 11, 1896.

Prof. Leeds delivered a lecture on "The Quantitative Determination of Micro-Organisms in Drinking Waters."

This lecture was followed by a talk on "Fluorescence," by President Morton, after which the members were entertained by the President at his residence.

PROF. LEEDS has been engaged by the city of Brooklyn to make and personally oversee all the chemical, microscopic, and bacteriological tests and investigations that may be required of the sources of the water supply of that city, in the next four months.

[illegible] the [illegible]
[illegible] from the
[illegible] different kind of wheels

[illegible] the [illegible]
[illegible] Falls Water
[illegible] of filtration his
[illegible] returned in by
[illegible] whose judg-
[illegible] The
[illegible] and [illegible] President

[illegible] Chemistry will be
[illegible] Quantitative Chemi-
[illegible] engineering
[illegible] with 154 illustra-
[illegible] important chapters are
[illegible] Analysis of
[illegible] Coal and Coke.
[illegible] Blast Fur-
[illegible] Analysis of Water
[illegible] of Water
[illegible] Coal and
[illegible] Use; Boiler
[illegible] Physical Ex-
[illegible] Chimney Gases
[illegible] Pintsch Oil Gas
[illegible] meter for C [illegible]
[illegible] Production of Gas
[illegible] Tests. Alloys.
[illegible] analysis. Tem-
[illegible] Lubricating [illegible]
[illegible] Blown [illegible]
[illegible] Pyrometry The
[illegible] Tables. The work is
[illegible]

[illegible] shops of Philadel-
[illegible] for the purpose of
[illegible] shipments.
[illegible] matters of detail, has been
[illegible] reference.

[illegible] apparatus of the [illegible]
[illegible] as in actual practice [illegible]
[illegible] This is the apparatus which was pre-
[illegible] Mr. M. N. Moore, '98.

The outfit comprises all the parts used on a locomotive, passenger car, and freight car, with the exception of the driver and tender brakes. The parts include an eight-inch Westinghouse air-pump which furnishes the compressed air, a main reservoir, in which the compressed air is stored; an engineer's brake, and equalizing discharge valve; an auxiliary reservoir, brake cylinder and triple valve, for a freight and a passenger car; a pump governor and a pressure retaining valve.

There are also a sectional engineer's valve and a sectional quick action triple valve for use in the explanation of the action of the brake.

This valuable apparatus is now erected against the wall of the east basement and is in running order.

THE "SWIFT" LUBRICATOR CO. presented to Mr. Moore, for use on the Westinghouse air pump forming a part of the brake outfit, one of their standard single connection sight feed lubricators.

THE EXECUTIVE COMMITTEE of the Alumni Association held its regular meeting on Thursday, Jan. 7th, at the office of Mr. F. E. Idell, Havemeyer Building, New York City. There were present, R. M. Dixon, '81, J. Day Flack, '87, H. de B. Parsons, '84, F. E. Idell, '77, F. D. Furman, '93, P. E. Raqué, '76, K. Torrance, '84, Wm. H. Bristol, '84, and A. Riesenberger, '76.

It was decided to hold the Midwinter Meeting of the Association on Friday evening, Feb. 19th, 1897, at 8 o'clock, at the German Club Hall, 6th and Hudson Streets, Hoboken, at the time set for the Promenade Concert and Dance. The committee appropriated $150 for the collation to be served on this evening.

The managing editors of the INDICATOR were appointed a committee to ascertain whether a favorable arrangement can be entered into for disposing of the advertising pages of the INDICATOR to some party for a fixed sum.

THE FIRST ANNUAL REUNION DINNER of the class of '95 was held at the Marlborough on the evening of Friday, November 6th. Fourteen members were present. Mr. Wm. Corbett presided and acted as toastmaster.

A toast on "Society" was answered by Mr. A. Lenssen, Jr., who entertained those present with some interesting remarks. Mr. A. Ganz answered the toast, "Progress at the Institute," pointing out particularly the additions made to the Electrical Department during the past year, and noting that the impulse to improvement was given by the presentation of the engine and dynamo on part of the class.

Regarding the Anniversary Celebration, the feeling of the members present was that the class should be properly represented, and take part in the exercises. A business meeting will be held early in January to give this matter due consideration.

ENGINEERING SOCIETY. The First Regular Meeting of the Engineering Society for 1896–97 was held Friday, Oct. 2, 1896. The election of officers resulted as follows:

President, A. Macklin Orr, Jr.; Vice-President, Warren Davey; Secretary

Rudolph V. Rose; Treasurer, C. R. Christy, Jr.; Executive Committee: J. Cromwell, Chairman, A. B. Miller, and R. S. Scott.

At the second meeting of the Society on Wednesday, Oct. [illegible], 1906, Mr. J. Cromwell, '07, read a paper on "The Locomotive in the Erection Shop." The third meeting was held Friday, Nov. [illegible], 1906. Mr. A. B. Miller, '05, read a paper on "The Practice of Indicating Locomotives."

At the next meeting, Tuesday, Nov. [illegible]th, Mr. F. G. Oakes gave a talk on "Steam Valves" and Mr. H. A. Joslin read a paper on "Heating with Live and Exhaust Steam."

At the fifth meeting Mr. L. B. Lent read a paper on "The Manufacture of Condensed Milk."

THE SENIOR CLASS organized with the following officers: President, Gordon L. Hutchins; Vice-President, E. R. Knapp; Secretary, A. M. Orr, Jr.; Treasurer, C. R. Christy, Jr.

INSTITUTE PERSONALS.

Vol. XVII., 1896, of the Transactions of the American Society of Mechanical Engineers, issued in November, contains the following contributions by graduates and members of the Faculty of the Institute:

GUS C. HENNING, '76.—Minutes of fifth conference on Methods of Testing Materials.

Discussion on: A Hydraulic Dynamometer; Determining Moisture in Coal; Effect of Temperature on Wrought Iron and Steel; Structural Steel Fly Wheels; Transverse Strength of Cast Iron.

WM. KENT, '76.—The Efficiency of a Steam Boiler—What is it?

Discussion on: Classification Catalogue for an Engineering Library; Coal or Oil as Fuel; Damper Regulation in Oil Firing; Determining Moisture in Coal; Effective Centre of Light from Photometric Burner; Experiments on Friction of Screws; Experiments with Automatic Mechanical Stokers; Forge-Shop Design; Oil Extraction; Power to Drive Disc Fans; Proportions of High Speed Engine; Reliability of Throttling Calorimeters; Retarders in Fire Tubes of Steam Boilers; Self Cooling Condenser; Structural Steel Fly Wheels; Tests of Steam Boilers with Different Kinds of Coal; Experiments with Throttling Calorimeter; Transverse Strength of Cast Iron; Western River Steamboat.

J. W. LIEB, JR., '80.—*Discussion on:* Tests of De Laval Steam Turbine.

H. DE B. PARSONS, '84.—*Discussions on:* Effect of Temperature on Wrought Iron and Steel; Saving Fuel in an Oil Refinery.

W. S. ALDRICH, '84.—*Discussions on:* Friction of Screws; Generation and Transmission of Water Power; Proportions of High Speed Engines; Tests of De Laval Steam Turbine; Water Power of Caratunk Falls.

H. A. BANG, '88.—*Discussion on:* Oil Extraction.

PROF. DENTON.—The Reliability of Throttling Calorimeters.

Discussions on: Friction of Screws; Saving Fuel in an Oil Refinery; Tests of Steam Boilers with Different Kinds of Coal.

PROF. JACOBUS.—Experimental Method of Determining the Effective Centre of the Light Emitted from a Standard Photometric Burner.

Discussion on: Experiments with Throttling Calorimeters.

At a meeting of the Amer. Soc. of Mech. Engineers, held Dec. 1 to 4th, in New York City, C. V. Kerr, '88, read a paper on "The Moment of Resistance," Geo. W. Colles, Jr., '94, a paper on "Metric vs. Duodecimal System," and H. de B. Parsons reported upon Tests of Fire-proofing material, as a member of the Society's Committee on this subject.

The following Stevens graduates registered their attendance at this meeting:

H. A. Bang,	E. M. Rosenberg,	E. H. Foster,
W. S. Ackerman,	Franklin Moeller,	Wm. Kent,
Fritz Uhlenhaut, Jr.,	W. H. Bristol,	Gus. C. Henning,
D. S. Jacobus,	W. D. Hoxie,	J. W. Lieb, Jr.,
Philip E. Raqué,	Jas. M. Cremer,	Geo. Gibbs,
F. E. Idell,	W. B. Yereance,	Paul Doty,
Albert Spies,	Geo. M. Bond,	H de B. Parsons,
E. A. Uehling,	Geo. W. Colles,	Edw. J. Willis,
A. Faber du Faur,	H. L. Gantt,	A. Riesenberger,
E. P. Thompson,	Wm. L. Lyall,	W. E. Quimby.
Henry Torrance, Jr.,	C. W. Thomas,	Hillary C. Messimer,
R. N. Baylis,	Kenneth Torrance,	Jos. R. McElroy.
John R. Slack.		

Professors Wood and Webb also attended.

ALEX. C. HUMPHREYS, '81, JOHN M. RUSBY, '85, ROLLIN NORRIS, '85, CARTER H. PAGE, JR., '87, and ALTEN S. MILLER, '88, attended the St. Louis meeting of the American Gas Light Association, held Oct. 27-29, 1896.

Mr. Page presented a paper on "Some Experiments in Interior Illumination" and Mr. Miller a paper on "The Separation of Water Gas Tar."

PAUL DOTY, '88, IRA F. WORTENDYKE, '89, and JOSEPH A. NORCROSS, '91, were admitted to membership in the Association at this meeting. Mr. Humphreys was elected Second Vice-President of the Association, and J. A. P. Crisfield a member of the Council.

'76.

JOHN M. WALLIS, formerly Division Superintendent of Motive Power of the Pennsylvania Railroad and located at Altoona, Pa., has been appointed General Superintendent of the Philadelphia and Erie Railroad Division Northern Central Railway Company of the Pennsylvania Railroad, office at Williamsport, Pa.

A. W. STAHL, U. S. N., was one of a board of two members, appointed to examine and report upon all matters pertaining to the construction of the U. S. steamer "Texas" which recently sank at her dock at the New York Navy Yard owing to the breakage of a valve guard in the engine room.

GUS C. HENNING, as Special Engineer for the Department of Buildings, New York City, has been making fire tests of so-called fire-proof floor constructions.

The American Machinist of Nov. 5th, 1896, contains an article on "Band Saws for Metal Work," which was translated and condensed for this journal from *Zeitschrift des Vereines Deutscher Ingenieure* by Mr. Henning.

'77.

The Electrical Engineer of Oct. 28, 1896, contains an illustration and a description of the Uehling & Steinbart pyrometer, which will reliably measure temperatures of 3,000 degrees Fahr. and over.

'78.

Lord Kelvin, in acknowledging the receipt of a copy of EDWARD P. THOMPSON'S book on Roentgen Rays, states under date Nov. 30, 1896: "I received it only a few days ago, but I have already looked nearly all through it with great interest. I have seen enough to know that I shall find much most useful information in it which will always be readily available because of the very excellent method and care with which you have given references to authors, dates and publications, and I am sure all who are interested in the subject will find your book exceedingly valuable. All your statements with reference to anything I have done on the subject are perfectly correct. I believe that hitherto nothing in the way of diffraction has been discovered for the Roentgen Rays. I doubt very much the genuineness of McKay's magnetographs, p. 25 of your book. No other experimenter as far as I know has given any confirmation of his experiments."

The Engineering Record, Dec. 5, 1896, gives a description and illustration of the De Bonneville Non-Freezing Tank Float, a device for preventing the interruption of automatic float regulators and indicators by the formation of of ice in water tanks. It is adapted for any pumping service.

A. A. DE BONNEVILLE has applied for letters patent upon this device.

'81.

H. C. WHITE has been appointed Chief of the Machinery Department of the Tennessee Centennial Exposition which will be opened next June.

Mr. White, who has been manager of the Phœnix Iron Works Company at Meadville, Pa., succeeds Prof. Wm. T. Magruder, also of the class of '81, who has accepted the chair of engineering at the Ohio State University, at Columbus, Ohio. *Business Chat*, the official bulletin of the Exposition, in announcing Mr. White's appointment states that "he has been drafter, erector, and superintendent of a large number of engine companies and comes highly endorsed as a man of force and ability and has to his credit the construction of a number of large plants."

On Sept. 15, 1896, U. S. Letters Patent were granted to R. M. DIXON for "certain new and useful improvements in gasholders for railway cars or the like" where gas to be utilized is stored under high pressure until required for use. The "regulator" used to reduce the high pressure in such service is placed in the receiver, thereby dispensing with much of the piping now employed, simplifying the system, and completely protecting the regulator.

The invention is illustrated and described in the *American Gas Light* journal of Sept. 28, 1896.

Mr. Dixon read a paper on "Car Heating by Steam" before the New York Railroad Club, Oct. 15, 1896.

'82.

GEO. GIBBS attended the September meeting of the Western Railway Club, held at Chicago, and participated in the discussion of the several sub-

jects that came before the meeting—"The Relation of Speed to the Power and Efficiency of Direct Current Series Electric Motors for Locomotives," "Performance of the Purdue Locomotive 'Schenectady'" and "Metal Underframing for Tenders and Cars."

'83.

J. E. SAGUE is a member of the committee appointed by the American Railway Master Mechanics' Association to report at its 1897 Convention on the question: "Which is the most economical, a boiler jacket of planished iron or a boiler jacket of common sheet iron or sheet steel painted? The general appearance, first cost and cost of maintenance to be considered."

'84.

ALEX. WURTZ, in an article published in *The Electrical Engineer* of Sept. 30, 1896, describes a compact form of apparatus designed by him for the protection against lightning of high potential power transmission circuits.

'85.

H. D. WILLIAMS delivered one of a course of lectures upon practical subjects relating to machinery, arranged by the executive committee of the Mechanics' Institute. The lecture was upon "A Newly Discovered Fundamental Law of Machinery," and was given at the auditorium of the Mechanics' Institute, Rochester, N. Y., Saturday, Dec. 12, 1896.

'86.

An article by F. N. MORTON on "The Use of Gas Engines; A Chat With the Power User," appeared in *Progressive Age*, Oct. 15, 1896.

E. F. WHITE has had constructed, from designs prepared by himself, an evaporation water cooler for cooling for re-use the heated circulating water from steam engine condensers. The apparatus depends for its action upon the cooling effects of "air-vapor absorption" under conditions of induced air circulation over an extensive water surface. The apparatus has been tested recently by the Dept. of Tests of the Institute. Some of the results of these tests are published, together with an illustration and description of one particular form of these water coolers, in *The Electrical Engineer* of Dec. 9, 1896.

'88.

WM. B. VERRANCE, engineer of bridges and buildings of the West Shore R. R., Weehawken, N. J., was elected a member of the Association of Superintendents of Bridges and Buildings at its Chicago meeting, held last October.

'89.

ALFRED GOLDSBOROUGH MAYER returned, on the 15th of July, 1896, from a trip of exploration of the great barrier reef of the N. E. coast of Australia. This expedition was fitted out by Professor Alexander Agassiz, to whom Mr. Mayer was assistant.

On his return to Harvard University Mr. Mayer passed his examination for the degree of Doctor of Science, and was soon after appointed curator of the Museum of Comparative Zoölogy of Harvard University.

ROBT. C. OLIPHANT and D. H. GILDERSLEEVE are associated in business at 126 Liberty Street, New York City. The former is manager of the New York Office of The Snow Steam Pump Works of Buffalo, N. Y., and the latter is the Eastern representative of the same company. They have opened branch offices at 35 Congress Street, Boston, Mass., and in the Drexel Building, Philadelphia, Pa.

'90.

CARL H. GRAF was married to Miss Corinne Battell Beedle, Wednesday, Nov. 18, 1896, at the Beneficent Congregational Church, Providence, R. I. Mr. and Mrs. Graf reside in Logan Street, Lawrence, Mass.

WM. N. CARLTON was appointed to test the capacity and economy of running of the new 30,000,000 gallon pumping engine of the Buffalo waterworks.

'91.

C. TEMPLE EMMET was married, in November, to Miss Alida Beekman Chanler, the youngest daughter of the late John Winthrop Chanler, and great-great granddaughter of the first John Jacob Astor, at Christ Church, Red Hook, N. Y.

'92.

HENRY C. MEYER, JR., was married to Miss Louise Griffen Underhill, Wednesday, Nov. 18, 1896, at St. Luke's Church, Montclair, N. J.

'93.

B. G. BRAINE, assistant engineer to Thos. E. Brown, Jr., C. E., 38 Park Row, New York City, has been elected to Junior membership in the Amer. Soc. of Mech. Engineers.

ALVIN BOODY, son of ex-Mayor David A. Boody, of Brooklyn, N. Y., was married, in November, to Miss Louise Weeks, daughter of Mrs. Henrietta W. Weeks, 187 Berkley Place, at St. John's Episcopal Church, Brooklyn, N. Y.

'94.

WM. A. JONES was married to Miss Sallie Pringle Fisler, on Thursday, Dec. 24, 1896, at Philadelphia, Pa. Mr. and Mrs. Jones reside at 4517 Regent Street, Philadelphia, Pa.

'96.

Power, October, 1896, contains a description of the apparatus and method used by R. T. KINGSFORD and WM. H. MACGREGOR for indicating an engine under rapidly varying load. This piece of apparatus was designed by Messrs. Kingsford and MacGregor for use in the preparation of their thesis, the subject of which was a "Test of the H. Ward Leonard Electric Elevator in Fahy's Building, Maiden Lane, N. Y."

R. T. KINGSFORD has accepted a position with the Rushmore Dynamo

Works in Jersey City [illegible] in designing and [illegible] a new line of [illegible]

[illegible] Consulting Engineer, [illegible] Street, New York [illegible]

[illegible] Brown, [illegible]

[illegible] Brown & Sharpe Machine & Tool Co., [illegible]

[illegible] Brooklyn, N.

[illegible] The De La Vergne Refrigerating Machine Co. [illegible] New York [illegible]

[illegible] in the [illegible]

[illegible]

[illegible] &

[illegible]

[illegible] Jackson of [illegible]

[illegible]

[illegible] Pump [illegible]

[illegible]

[illegible] Hoboken,

[illegible] Heating &

[illegible]

[illegible]

[illegible] &

[illegible]

ATHLETICS.

FOOTBALL.

The football team closed its schedule with so many defeats that the season cannot be considered other than an unsuccessful one.

The fault does not rest with the individual members of the team, for their work was of the hard and faithful order; but with the student body of the college, which gave the team neither encouragement nor support. It is absolutely essential for the development of a good 'varsity, that it have in its practise a scrub-team to line up against. Yet of all the men in the Institute who play the game, but four or five would put in an appearance at the grounds to give the 'varsity practise. A 'varsity cannot under these circumstances be expected to play winning games against first-class teams.

Then again Stevens is unfortunate in lacking experienced men to act as coaches. This should not be the case, when it is considered how many of her alumni have made themselves famous on the gridiron. The presence of a few of these men would infuse new life into the game; and it is earnestly hoped by the students that next fall will find a formidable array of coaches from the alumni ranks.

Following is the schedule of games played:

Oct. 3—Elizabeth A. C. vs. Stevens at Elizabeth		46—0
" 10—Y. M. C. A. of Oranges vs. Stevens at Hoboken		12—6
" 17—Irving Club vs. Stevens at Eastern Park, Brooklyn		8—6
" 21—Rutgers " "	New Brunswick	10—0
" 24—N. Y. University "	Ohio Field, N. Y	40—0
" 31—Elizabeth A. C. "	Elizabeth	52—0
Nov. 3—N. J. A. C. " "	Bayonne	40—0
" 11—Rutgers " "	Hoboken	0—10

E. A. C. VS. STEVENS.

Against such veteran players as Langford, Smith, Stillman, Knapp, and Hopkins, Stevens made a weak defense. Although outplayed, it was by no means a disgrace to be beaten by a team which, during the season, played Yale to a standstill. In the first game Captain Hutchins received injuries which necessitated his retiring for the rest of the season, Buckley succeeding him as Captain.

O. Y. M. C. A. VS. STEVENS.

No excuse can be offered for the miserable playing of Stevens in this game. Although the first half closed with the score 6—4 in Stevens' favor, and looked like a sure victory, the second half upset all calculations, the team going completely to pieces.

IRVING VS. STEVENS.

Stevens took a decided brace in this game, played excellent football, and the result was a well contested struggle. It seems rather remarkable that although Irving beat N. J. A. C. by the same margin that they did Stevens, and N. J. A. C. won from N. Y. U. by a score of 22—4, Stevens was defeated by both teams 40 to 0.

RUTGERS VS. STEVENS.

A weak line, and poor judgment in playing a set of backs, who were really on the sick list, when reliable substitutes were on hand, was the cause of Stevens' defeat in the first Rutgers game.

Stevens played the second with that snap and vigor which was entirely absent from previous games, excepting the game with Irving; and that, combined with good team work, was the means of turning the tables on Rutgers and securing for Stevens her only victory of the season.

In both aggressive and defensive work the team showed considerable ability and that do-or-die spirit was plainly shown at critical moments. The interference was much better than the best of previous games, and the backs followed it closely.

The line-up of the second game was as follows:

Rutgers.		Stevens.
[illegible]	Right End	Tock.
[illegible]	Right Tackle	Hughes.
[illegible]	Right Guard	Brett.
[illegible]	Centre	Lunger.
[illegible]	Left Guard	Davey.
[illegible]	Left Tackle	Buckley (capt.). Merriam.
[illegible]	Left End	Stanley.
[illegible]	Quarter Back	Davis.
[illegible]	Right Half Back	Christy.
[illegible]	Left Half Back	Sofio.
[illegible]	Full Back	Mathey.

[illegible] Orange A. C. [illegible]

[illegible]

[illegible] VS. STEVENS PREPS.

[illegible] hard and plucky game, proved to be [illegible] and outplayed them, winning by a [illegible]

[illegible] VS. FRESHMEN.

[illegible] on the gridiron took place on November [illegible] and most exciting game in

the history of the St. George Cricket grounds resulted in a victory for the Sophomore Class of '99 by a score of 5—4.

1900 had the advantage in weight, but '99 more than offset this by their good team work, bucking the line and running the ends almost at will; in fact, centre was the only part of the line they were unable to work for gains. On the defensive neither team was strong, they being equally matched in this respect.

In the first half, after '99 had rushed the ball down the field to 1900's 5-yard line, the ball was given the freshmen for offside play. Their full-back punted to their 40-yard line, where Hagstoz made a free catch. It was then that Kirby won the gratitude of his classmates by sending his place kick squarely between the goal posts.

In the second half, through a series of fumbles by '99, aided by a run of 15 yards by Appleton, 1900 scored a touchdown, but failed at goal.

The line up was as follows:

Sophomores ('99)		Freshmen (1900)
King	R. E.	Raphel. / Brooks.
Beck	R. T.	Jennings.
Post	R. G.	Newman.
Morley	Centre	Percy.
Kirby	L. G.	Ferguson.
Campbell	L. T.	Merriam.
Everett	L. E.	Barlow. / Underhill.
Hagstoz	Q. B.	Myers (Capt.)
Stanley (Capt.)	R. H. B.	Appleton.
Berg	L. H. B.	Bradley.
Westerfield	F. B.	Chadwell. / Raphel.

Referee, Mr. Cuntz.

Goal from field, Kirby. Touchdown, Appleton.

TENNIS.

The fall tournament contained such a large number of entries that it was impossible to get to the final round before the cold weather set in.

As it stands now, Grady and Williamson have yet to play for the '97 class championship. Scott, '98, plays the winner of that match. Cartwright, '99, who defeated Durrie, the freshman champion, meets the winner of the '97-'98 match for the College championship.

The tournament will be finished in the spring.

LACROSSE.

In all probability an inter-class series of Lacrosse games will be arranged for the early spring.

The absence of the valuable practice games with Crescent will be sadly missed this year. Crescent goes to England to play all the crack teams there.

LIST OF MEMBERS OF THE ALUMNI ASSOCIATION OF STEVENS INSTITUTE.

It is contemplated to publish in the January number of each year a list of the members of the Alumni Association, together with the business address of each.

Care has been taken to make this list as correct as practicable; omissions and errors will be corrected in succeeding lists, if the facts are brought to our notice.

All active members have received the degree of Mechanical Engineer, excepting those whose degrees are stated in foot notes.

Degrees in addition to M. E. conferred upon members are noted after the names of the recipients. Associate members are indicated by the word "Assoc." following the name, and preceding the date of the class with which the member was identified.

ACKERMAN, WILLIAM S., '91—Consulting and Constructing Engineer, New York City, or 92 Washington Street, Paterson, N. J.

ADAMS, HARRY H., '93—Foreman, Motor Repair Shops, Consolidated Traction Co., Jersey City, N. J.

ADRIANCE, WILLIAM A., '85—Adriance, Platt & Co., Manufacturers of Agricultural Machinery, Poughkeepsie, N. Y.

AGUILERA, ANTONIO, JR., '85—353 W. 57th Street, New York City.

ALDEN, JAMES S., '84—Assistant Manager, Brick Factory of L. H. Alden, Passaic, N. J.

ALDRICH, WILLIAM S., '84—Professor of Mechanical Engineering, West Virginia University, Morgantown, W. Va.

ALLAN, PERCY, '95—The Safety Car Heating and Lighting Co., 160 Broadway, New York City.

ANDERSON, ROBERT M., '87—Assistant Professor of Applied Mathematics, Stevens Institute of Technology.

ANDERSON, ST. GEO. M., '94—Assistant to State Chemist, 103 W. Franklin Street, Richmond, Va.

ANGELL, F. J., '94—Draughtsman, Solvay Process Co., Syracuse, N. Y.

ANTZ, OSCAR, '78—Lake Shore and M. S. Railway Car Shops, Cleveland, O., also Instructor in Mechanical Engineering, The Correspondence School of Technology, Cleveland, O.

ARRISON, P. '95—Thomson Meter Co., Brooklyn, N. Y.

ASPINWALL, JOHN, Assoc., '81—Barrytown, N. J.

ATKINS, HAROLD B., '92—Roselle, N. J.

ATWATER, C. G., '91—Constructing Engineer, Semet-Solvay Co. of Pennsylvania, Dunbar, Pa.

AXFORD, WILLIAM B., '93—Vice-Pres. & Chief Eng'r, The Harriman Wrought Iron Co., 76 Montgomery St., Jersey City, N. J.

BADENHAUSEN, JOHN P., '96—Consolidated Iron Works, Hoboken, N. J.

BALDWIN, OSCAR, '85—Managing Director, Westinghouse Electric Co., Ltd., 32 Victoria St., London, S. W., England.

BALL, B. C., '95—Chief Draughtsman and Designer, with Ball & Wood Engine Co., 470 Morris Avenue, Elizabeth, N. J.

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U. S. Coast Survey, 1894. Part 2.

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Yearbook, U. S. Department of Agriculture for 1895. By C. W. Dabney, Jr.
The Experiment Station Record. Vol. IX.

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Comptes Rendus. Vols. 120-121.
Proceedings Inst. of Civil Engineers. Vol. 124. By James Forrest.
Pouvoir Calorifique des Combustibles, Solides, Liquides et Gazeux. By M. Scheurer-Kestner.

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11th Census Insurance. By Charles A. Jenney.
Mineral Resources of the U. S., 1895.
Geological Atlas of U. S., Montana.
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Geological Atlas, U. S. Eureka District, Nevada. By Arnold Hague.
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U. S. Census Report, 1890. Crime, Pauperism, and Benevolence in the U. S. By F. H. Wines.

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The Older Mesozoic Flora of Virginia. By W. M. Fontaine.
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Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of N. J. By R. P. Whitfield.
Dinocrata. By O. C. Marsh.
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Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of

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[illegible] Thesis. The [illegible] The Thesis was [illegible]

[illegible] Master at works of the [illegible] assistant to the President and General [illegible] installing [illegible] was elected Vice-President [illegible]

When the [illegible] the manufacture of wire rope, he devised, patented and installed [illegible] machinery.

The following [illegible] patents [illegible] some of those taken out by him [illegible]

[illegible] February 24, 1880.

[illegible] Wire, April [illegible], 1880.

[illegible] Wire [illegible] the Waste Hydrogen [illegible]

[illegible] Wire [illegible] 1885.

[illegible]

[illegible] March [illegible], 1885, and April 28, 1885.

[illegible] 1885.

Metallic Spring Mattress, February 9, 1886.
Machine for making Wire Ropes, March 1, 1887.
Telegraph Wires, March 13, 1888.
Wire Bale Tie (the Anchor Tie), April 10, 1888.
Machine for making Wire Rope, two patents, October 9, 1888.
Grip Mechanism for Cableways, May 3, 1892.

In 1888 installed the machinery for manufacturing the Wire Bale Tie known in the market as the Anchor Tie.

In 1890–91 he planned and installed the Wire Rope tramway for the East Shore Terminal Co. at Charleston, S. C., for conveying cotton. A view of the discharge terminal of this line, looking over Charleston harbor, is shown in the accompanying engraving.

During many years past has been concerned in laying out many other wire rope tramways and haulage plants built by the Trenton Iron Co. and described by him in a volume entitled "Wire Rope Transmission in all its Branches," issued by the same company.

Mr. Hewitt was the first President of the Alumni Association of the Stevens Institute and was again elected in 1894. He was Alumni Trustee of the Institute in 1893 and 1894. He has been a member of the American Society of Mechanical Engineers since its formation in 1880. His papers read before the above Society are as follows:

The Continuous Rod Mill of the Trenton Iron Co., volume 2, page 70.
Novel Hammer-head and Die, volume 6, page 77.
Wire Rope Fastenings, volume 9, page 671.
Discussion of "A Method of Making Tubes from Solid Bars, by Geo. H. Babcock," volume 8, page 564.
Discussion of "Notes on Results Obtained from Steel Tested Shortly after Rolling, by Edgar C. Felton," volume 9, page 38.
Discussion of "Steel Car Axles, by John Coffin," volume 9, page 135.

As a member of the Engineering Society of the South, he contributed a paper on the "Effect of Bending on Wire Rope."

Contributed numerous papers to various technical journals, among which were the following:

Construction and Management of Roll Trains for the Manufacture of Heavy Bars, Rails, and Girders, published in the *Iron Age*, volume 16, October 21, 1875, page 1, October 28, page 7, November 4, page 3, November 11, page 1, November 25, page 11, and December 2, page 1.

[illegible] Rail Trains. Published in the *Journal of the Franklin Institute*, volume [illegible], page 102.

[illegible]onstruction of [illegible] of Rolls for Reducing Metal. *Engineering and Mining Journal*, August [illegible].

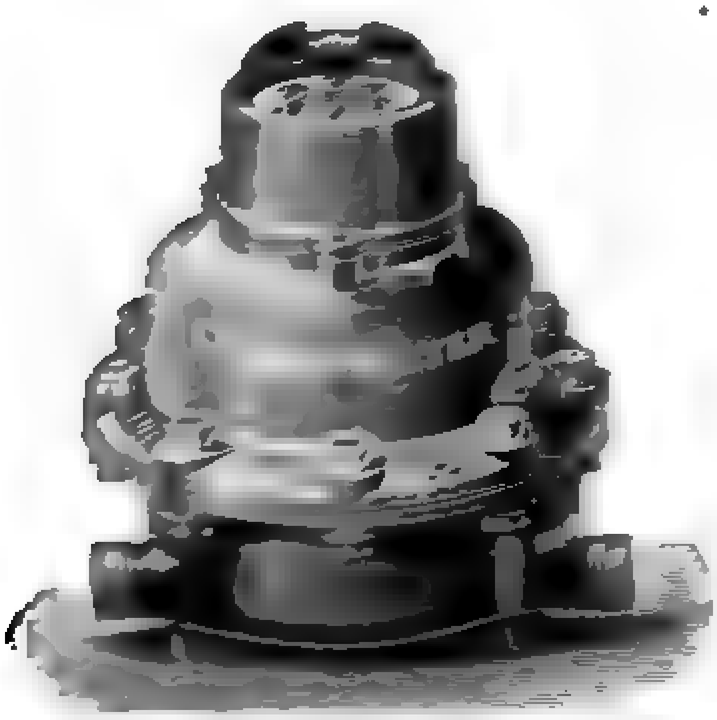
Transportation [illegible] Wire Rope Tramways. *Engineering Magazine*, volume [illegible], page [illegible].

[illegible] for Unloading Vessels. *Cassier's Magazine*, volume [illegible], page [illegible].

[illegible] for Handling Heavy Loads. [illegible]tone. *Cassier's Magazine*, volume [illegible], page [illegible].

Transmission of Power by Wire Rope. *Engineering News*, volume [illegible], page [illegible].

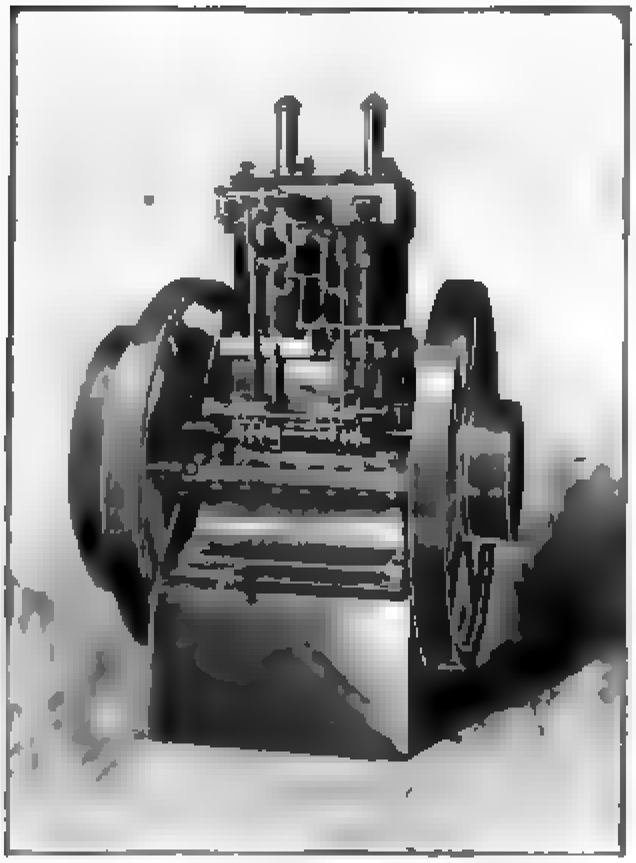
[illegible] Lewis H., M. E. Graduated in [illegible]. Went into the employment of the National Meter Co., at that time building a water meter called the Gem Meter. This was a small concern employing about six workmen and boys. Mr. Nash began at once designing improvements in the meter and its method of manufacture and after a few months produced the structure known as the "Crown Meter." This was the first of a large class which may be described as single piston rotary [illegible] though it has [illegible] been in the market for more than [illegible] it still holds its place as the best of its kind.



[illegible]

[illegible] Mr. Nash invented several other forms of water [illegible] the Empire Meter, the Nash Meter and the Im[illegible] Gem Meter, which the same company, now grown to [illegible] proportions and employing many hundreds of men, are at [illegible] the thousand. The single piston ro[illegible] practically superseded all other forms of displace[illegible].

There are about [illegible] U. S. Patents on water meters which Mr. [illegible] has taken out and assigned to his company.



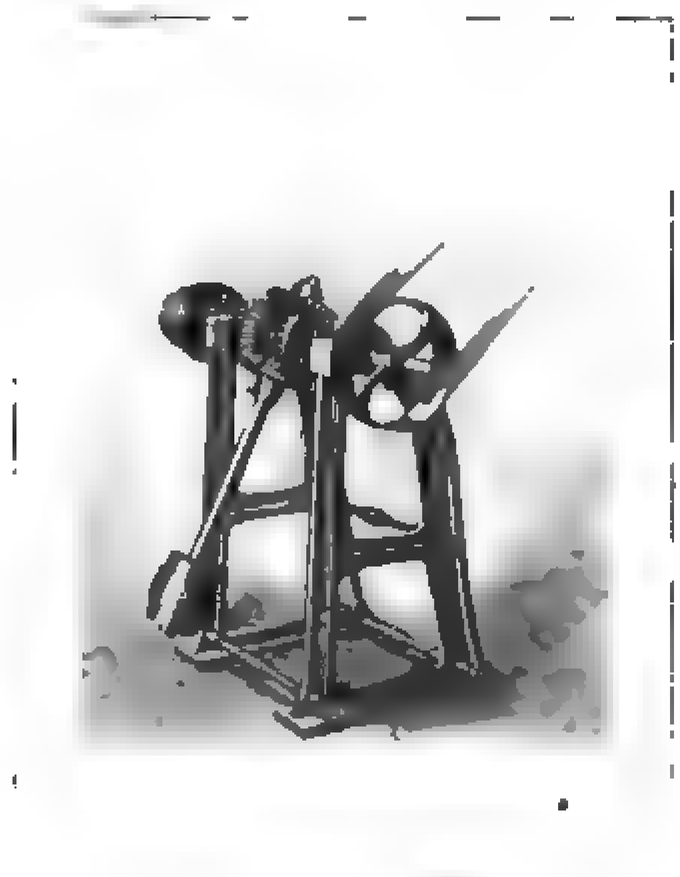
VERTICAL GAS ENGINE.

In 1887, after preliminary study and experiment Mr. Nash began to turn out for his company gas engines of the vertical cylinder type, with the cylinder above the crank-shaft.

This form was looked upon with little favor by engineers generally when first introduced by Mr. Nash, but since its advantages have been demonstrated by practical experience, it is being adopted by all other builders of gas engines.

Mr. Nash has taken out more than 50 patents in relation to gas engines.

Beginning with engines of a small size Mr. Nash and his company have gradually extended their dimensions until now they are building some of 200 horse power.



KENT TRANSMITTING DYNAMOMETER.

William Kent, M. E. Graduated in 1876. During the time that he was in attendance at the Institute Mr. Kent designed a form of Transmitting Dynamometer which is represented in the accompanying cut. On graduation was at first employed in the Mechani-

THE STEVENS INDICATOR.

VOL. XIV. APRIL, 1897. NO. 2.

THE 25TH ANNIVERSARY OF THE FOUNDING OF THE STEVENS INSTITUTE OF TECHNOLOGY.

The 25th anniversary of the founding of the Institute was fittingly observed on February 18th and 19th, 1897, in accordance with the programme announced in the last issue of the INDICATOR.

The celebration was in every sense a very gratifying success, and was the means of bringing together a larger number of the alumni of the Institute than had been assembled upon any other occasion. Many came from distant points to participate in the festivities and to manifest their attachment for their alma mater. The occasion was indeed a memorable one in the history of the Institute and successful beyond the expectations of even those who were acquainted with the full details of the programme to be presented.

THE BANQUET.

The festivities began with a banquet at the Hotel Waldorf, New York City, on Thursday evening, Feb. 18th, which was attended by nearly 300 persons.

Many of the graduates present had not met their classmates or fellow alumni and professors since graduation, so that the reunion which took place in the reception rooms for an hour or more before the assemblage sat down to table was a very pleasant feature of this evening's entertainment.

Each guest was presented by President Morton with a handsome souvenir in the form of a pamphlet, beautifully illustrated, containing a poem, dedicated to Mrs. Martha B. Stevens, entitled "Per Aspera ad Astra," the motto of the Stevens family, which was written by President Morton for the occasion. Handsome menu cards were provided, prepared from a design by Mr. L. D. Wildman, '90. The decorations of the banquet hall were elaborate and tasteful, and the room presented a most charming scene when the guests, a considerable number of whom were ladies, were all seated.

The speaking began a little after 10 o'clock and lasted nearly two hours.

Through the kindness of President Morton the INDICATOR is able to publish the addresses in full.

Mr. S. Bayard Dod, President of the Board of Trustees, presided, and introduced the speakers with remarks that were very happily chosen.

In announcing the first toast, "Our Founder" (applause), he said:

"I am happy to state that we have with us an old-time and trusted friend of our founder and of our founder's father. I know of no man who knows more about the founding of useful institutions, who has a nobler record in charity work in New York and New Jersey, and there is no man who can expect a greater majority for the first Mayor of Greater New York than Mr. Abram S. Hewitt." (Applause.)

The toast as announced was as follows:

OUR FOUNDER.

"The Pyramids have forgotten *their* founders."
— *Thos. Fuller.*

"Si monumentum quaeris, circumspice."
If you seek his monument, look around.
(From the tomb of Sir Christopher Wren in St. Paul's Cathedral.)

to which Hon. ABRAM S. HEWITT responded:—

Mr. Chairman and Ladies and Gentlemen:

If anything were required to enhance my appreciation of the honor which the Chairman confers upon me, by asking me to respond to the toast in memory of the Founder of the Stevens Institute, the deficiency would be supplied by the cordiality of this reception, for which I return my sincere thanks. If, as the Chairman suggests, New Jersey could have its way, I do not think that New York would be the gainer, so far as its next Mayor is concerned, but there is no doubt that if New Jersey had not been protected by constitutional limitations from being included in the proposed city, she would have supplied the conservative force, for which she has a just renown, and the result might be more satisfactory to all concerned than it now seems likely to be.

A festive occasion like the present is not suited to any formal account of the personal history or of the achievements of the Founder of the Stevens Institute. That duty has its proper place and will doubtless be performed by some one who is better qualified than I am to do justice to the remarkable man, to whom the Stevens Institute owes its origin, and to the unselfish devotion of President Morton, who has secured its present development. I shall therefore in what I have to say limit myself to some personal reminiscences which will serve to show not so much the achievements of the Stevens family, as to give some idea of the kind of men they were in training, in character, and in devotion to the highest ideals of modern civilization. This I am sure is the reason why Mrs. Stevens paid me the great compliment of asking me to come here and to speak to you on this interesting occasion.

I suppose I am the only person in this room, and one of the very few persons alive, who can say that he has seen and known the entire family from its Founder, John Stevens, who was born in 1745, before the Revolution, as well as his children, grandchildren and great-grandchildren, who have gathered round the old ancestral home on the other side of the Hudson River. It may seem strange that any one should be here who knew the elder John Stevens, but it so happened that when I was a boy of about six years of age, I was taken by my father to Hoboken for

the purpose of being introduced to John Stevens, because at that early age I had witnessed from the wharf at the foot of Jay Street a magnificent steamer, with four ponderous smoke-stacks passing rapidly up the Hudson River, and had asked whose steamer it was and where it was going. My father told me that there were two of these boats, the finest in the world, and that they had been built by the Stevens family of Hoboken. I said, "Do you know the Stevens family?" to which he replied, "Yes. I will take you to Hoboken, and let you see the greatest engineer of his time."

And so before 1830, somewhere between 1828 and 1830, I was taken to Hoboken and introduced to John Stevens, who was then a man of eighty-three years of age, but in possession of all his faculties, and manifesting the greatest possible interest in this visit from an old friend and a young boy. Familiarly he called my father "John," for both bore the same name, and my father said, "This is my son. I want him to see you and know you," and then they began to talk of old times and particularly of this remarkable story, which was often repeated to me by my father afterwards, or else possibly I should not remember it so well.

My father was the draughtsman and the pattern maker, who had come out from England, with a party of machinists to erect the first stationary double acting condensing engine which was put at work upon the American continent. It was built by Boulton and Watt at the Soho Works, near Birmingham in England, and was brought out and erected at Center Square in Philadelphia for the purpose of supplying that city with water, before the Fairmount Works on the Schuylkill River were erected. In a monograph which I have seen, it is stated that John Stevens saw the first engine that was "built" in America, but he did more than this—he not only saw the first condensing engine that was erected in America, but he had built for himself the first Watt engine which was constructed in America; for that party of men, at the head of whom was an engineer by the name of Smallman—whose name possibly none of you have ever heard—and whose iron founder was a man by the name of Rhodé, the predecessor and instructor of James P. Allaire, who founded the Allaire Works in this city, where many of the engines which were sub-

sequently designed by the Stevens family were built, these men, with my father as draughtsman and pattern maker, erected a new Soho Works at Belleville, N. J., near the old copper mines known usually as the Schuyler mines. There John Stevens came and there he had built the first low pressure engine that was constructed upon the American continent. He therefore not only saw the first one erected but he himself ordered and paid for the first condensing double acting engine that was built upon the American continent. (Applause.)

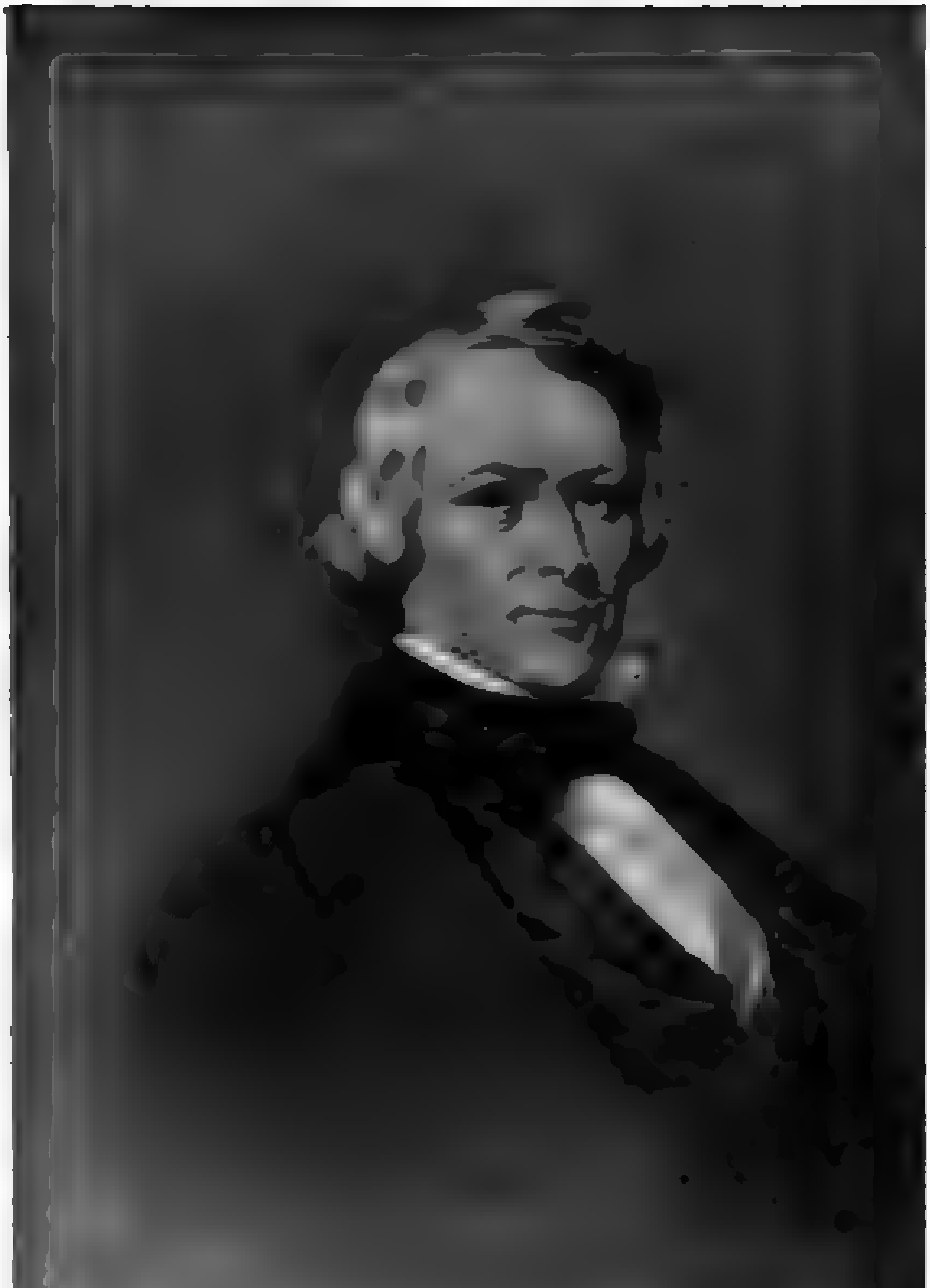
Of course this interview with John Stevens made a profound impression upon my mind, and on my way home my father said, "Yes, that engine was put in a boat in which I traversed the route from Belleville to New York and back again, John Stevens being the owner, the builder and the captain of the boat, and Mr. Smallman and Mr. Rhodie and myself being the passengers, and we came to New York in that boat nine years before Fulton put the *Clermont* on the Hudson." (Applause.)

Portions of the engine thus constructed were for a time preserved in the Stevens Institute, and must be there still, unless they have been placed in the National Museum at Washington; but the boat in which the engine was placed must not be confounded with the one, whose model I see here upon the table, built later in 1804, with a double screw, and which preceded Fulton's boat by four or five years. I only remember that the Belleville boat had a stern wheel, and my father said that Mr. Stevens during the trip remarked that wheels should have been placed upon the side and not at the stern. But upon this ground I shall not further trespass, as I understand the subject has been assigned for a more competent authority to deal with in the course of the evening.

I never saw John Stevens again. My next knowledge of the Stevens family was when I was a student in Columbia College about 18[illegible]. We used to play ball upon the college grounds, and the game (Base Ball) would doubtless be regarded by modern college teams as altogether too tame for the much greater athletic development of this generation. It was a very simple game, and it had one drawback. We often knocked the ball out of the field, and it generally landed in the rear of a house which fronted upon

Barclay Street. On one occasion, while we were playing ball, we exhausted our stock, and on searching our pockets we found that there was not money enough in the entire team to buy a new ball from a neighboring toy-shop. (Laughter.) The result was that I was made a committee of one to go around to Barclay Street and ring the doorbell of the house, where most of the balls were known to have disappeared. It was a basement house, I remember it perfectly well.

There came to the door a middle aged woman with a benevolent face, to whom I explained that we had lost a ball, which was then in the back yard, and asked her to be good enough to let me go in and pick it up. She seemed to hesitate, and while she was hesitating, a gentleman appeared from the room immediately adjoining the hallway, who made a very great impression upon me. I was a diffident boy. I used to blush when I was spoken to, and positively I feel very much inclined to blush now in telling this very simple story in this intelligent presence. He looked at me for a moment very benevolently and said, "So you want a ball." And he added, "Will you be satisfied with one ball?" I said, somewhat embarrassed, "Yes, sir." He smiled, and I may as well say here now, as at any other time, that a more genial, attractive and lovely face I have never seen in this terrestrial sphere. His presence was noble and his manner sympathetic, but on that occasion I was very timid. He turned and said to the woman, "Margaret, go and get the basket." She disappeared but came back in a few moments with a basket of the old fashioned kind, such as eggs used to be carried in, and in this basket were not less than I should say twenty-five or thirty balls. Said he, "Are all these balls yours?" I said, "I suppose that they must be, sir." "Well," said he, "every one of them has broken a window in my music room." "Well," said I, "we didn't do it on purpose." "No," he replied, "I know that. I was a boy myself once, and I have no doubt that I have broken hundreds of windows in my time." Then he added, "Take them, go back, enjoy yourselves, and when you have broken all the windows in my music room, go over to Hoboken and there you will find a fair field in which you can play without breaking any windows." (Applause.) That was the greatest mechanical engineer, the greatest naval engineer,



ROBERT L. STEVENS.

the greatest railroad engineer which the nineteenth century has produced—Robert L. Stevens. (Great applause.)

We continued to play ball and to break windows, but I do not remember that any other committee ever ventured to ask for a return of the stray balls. Personally I saw no more of the Stevens family until the year 1846, more than fifty years ago, when Mr. Edwin Stevens sent for me one day and said that the Camden and Amboy R. R. Co. wanted to get two thousand tons of rails, and that it was impossible owing to the great scarcity of the article to procure them in time to be laid in that year. He said, however, that he was prepared to pay the cost of importation, if my firm would undertake to make the rails at a price which will make the mouth of my friend Carnegie water, or to use the more orthodox Scotch phraseology—" will make him lick his chops with envy "—when I tell him that the price offered was ninety dollars per ton. (Great laughter.) We had just built a little rolling mill at Trenton for the manufacture of wire. Now wire is very much the reverse of a railroad bar. Mr. Stevens said, " I want you to make two thousand tons of rails, weighing sixty-five pounds to the yard," which was the heaviest rail at that time ever made in the world. I afterwards discovered that the pattern, like all the inventions of the Stevens family, was peculiar, and somewhat difficult to roll. Nevertheless, I finally agreed to make the attempt, and as a matter of fact we succeeded in delivering two thousand tons of rails, for which we received the sum of one hundred and eighty thousand dollars in hard cash, an amount sufficient at this time to pay for ten thousand tons of rails, according to the latest quotations which Mr. Carnegie has just whispered in my ear. (Applause.)

Robert L. Stevens, as you all know, was the designer of what is known as the flange rail. He had it made in Wales at the works of Sir John Guest, and with such expedition that within two years from the time of undertaking the practical scheme of building the Camden & Amboy R. R., that railroad was constructed, running and carrying passengers and freight with entire success between the cities of New York and Philadelphia. Robert L. Stevens and his brother Edwin, who was the business manager of the enterprise, thus performed in two years a feat

which at that time, if you will consider the development of the mechanical arts, the state of the financial transactions of the world, and the unknown elements which entered into the problem, was a greater performance than if any man were to undertake at this time to build a road from New York to San Francisco in two years. (Applause.) The world never saw a greater triumph than the construction of that road, and out of its operation have come all the developments which have culminated in the modern railway and its wonderful appliances. They had to provide cars, because there was no model for cars. They were, however, the proprietors of the Union line, which carried passengers from New York and Philadelphia. Forty coaches, often in a line, would start from New Brunswick (on the arrival of one of the Stevens' steamboats) across the State of New Jersey, drawn by thoroughbred horses to Trenton, where the old buildings which were constructed by the Stevens family of solid brick and mortar stand to this day, and where the house still remains in the possession of my family, in which John C. Stevens, who was the Superintendent of the Union line, resided and superintended the business; for the peculiarity of the Stevens family was that whatever they undertook to do they did themselves. They had subordinates, they had trusted men, they had tried assistants, but the superintendence of the work to the minutest part, was done by John and Robert and Edwin Stevens. Together they built railroads, and ferries, and steamboats, and yachts, and iron-clad batteries; and this suggests the first lesson which I would draw from this necessarily sketchy statement for the benefit of the young men who are here assembled. It is this, that these three brothers worked as though they were one man. No one ever heard of any quarrel or dissension in the Stevens family. They were workmen themselves and they were superior to their subordinates only because they were better engineers, and better men of business than any people who, up to that time, had undertaken the business of transportation within the limits of the United States. More than any other men, whom I have ever known, they demonstrated the truth of the saying, "Behold, how pleasant a thing it is for brethren to dwell together in unity." (Applause.)

FIRST TRAIN ON CAMDEN & AMBOY R. R.

But I am asked to speak especially of the Founder. I have been speaking of the founders, John Stevens, the elder, John C. Stevens, Robert L. Stevens and Edwin A. Stevens, who were the founders and pioneers who have made this country what it is—the miracle of the ages, the admiration of the world. (Applause.) No one who cannot go back as I can to the time when there were no railways, to the time when there were no ocean steamers, when there were no telegraphs, no telephones, no armored navies, no access to any point beyond the Mohawk Valley, when the Great West was yet unsettled, when this great Empire was a wilderness—no one who cannot recall this primitive condition of things and did not see it, can realize what the Stevens family has done for America. (Applause.)

"Tantæ molis erat Romanam condere gentem." *

But I am taking too much time. (Cries of "No. No. Go on.") I have said enough of the achievements of this remarkable family, but I have not said enough of the other side of their personality—the lovely, gentle, sweet and human character which belonged to the father and to the three brothers, of whom I have spoken. I told you that I was a poor and diffident boy, yet when I was brought into contact with them, I never was made to feel that there was any difference either in social standing or in wealth, in years, or even in ability. I was welcomed to Castle Point in my early youth, just as I would be to-day by the honored mistress of that noble mansion. They did not believe that the acquisition of wealth was sufficient for the development of human nature. They knew that the emotional side of man's nature controls in the long run, and that the reason is always the servant of the imagination. Hence when they ran stage coaches, they had fine horses; when they ran boats for profit to Albany, they adorned them with pictures and beautiful objects. The sense of beauty was ever present in everything they did. Their leisure hours were regaled by the charms of art and music. I suppose no connoisseur, who ever lived in New York, was superior to Robert Stevens in his knowledge of music, and no man ever lived who enjoyed it more. I heard him once tell how when

* Virgil's Æneid Book I, line 33. To found the Roman nation was (a thing) of so great labor.

for the first time he heard the angelic notes of Malibran, the golden Gates of Paradise seemed to open and the Heavenly Hosts to be lost in adoration.

It was thus the characteristic of the Stevens family, that while they have always had an eye to main chance, they have never neglected any opportunity, either for rational enjoyment, or for the improvement of the æsthetic side of the world in which they lived. Therefore it is not surprising that Edwin Stevens, who, as I have said, was first of all a man of business, and who as an engineer was doubtless inferior both to his father and his brother, but who was nevertheless no contemptible engineer, for his judgment I assure you on practical matters was as sound as that of any man I ever knew; I say it is not surprising that when he came to make a disposition of the great fortune which had been created by the ability, the foresight, the energy and the courage of the family, that he made provision for the diffusion of the elementary principles of mechanics and of the extraordinary practical knowledge which they had acquired through so many difficulties, by the agency of an institution of learning. The less famous engineer became thus the greater benefactor of mankind. (Applause.)

The Stevens Institute was created by Mr. Stevens' will which was signed on the 15th of April, 1867, on the night before the day when Mrs. Stevens and her children came upon the *Great Eastern* with Mr. Stevens for that trip from which he was never to return. It was my good fortune, in fact, it was my understanding with him, that I should accompany him on that trip. He was very anxious to understand the *Great Eastern*, and so was everybody that ever had anything to do with that ship, and I doubt if anybody succeeded. (Laughter.) I only refer to it on this occasion because from the time we left New York until we arrived at Brest, the ship was subject to a chapter of accidents of a very amusing character. Mrs. Stevens will remember that it was a matter of wonderment every day what was going to happen next, for everything did happen that nobody wanted to happen during that eventful voyage. But I refer to it now because I had many conversations with Mr. Stevens on the subject of the Stevens Institute. Mr. Peter Cooper, my father-in-law, had founded the Cooper In-

stitute, and it had been in operation for eight years at that time. Mr. Stevens was very anxious to know exactly the methods upon which it was conducted, and how far it had fulfilled the expectations of the founder. Of course I explained to him that Mr. Cooper was a mechanic, and that he had founded his institution for mechanics; that as the Stevens family were engineers it was natural and fitting in every way that the Institution which he proposed to found should be devoted to the education of engineers. I explained to him that all the resources of the Cooper Union were used in giving the education which the mechanic needed, and that what was wanted in this country was a higher institution which could start where the mechanic ended, and produce the engineers who were to become the leaders of modern enterprise and the captains of industry. (Applause.)

Mr. Stevens entered heartily into this view of the subject, so that I have reason to know that while the language of the will provides for an "an institution of learning," President Morton, with the approval of Mrs. Stevens and Mr. Dod and Mr. Shippen, as Trustees, merely carried into effect the views which Mr. Stevens entertained as to the objects of the Institution and the position which it should occupy in the domain of education.

But I referred to the voyage which we took together for the purpose mainly of showing some of the traits in the character of Mr. Stevens which made him so interesting and so lovable to all his friends. The *Great Eastern* was going out practically in ballast with no cargo, but with passengers who were on their way to visit the great Universal Exposition in Paris, and which was in reality one of the wonders of the world. To replace the cargo [illegible] tons of water had been pumped into the space between the outer and the inner shell of the ship, and the water ballast was relied upon to keep her in trim. As a matter of fact, however, some one had neglected to close up the bulkheads, so that the water had free passage from one side of the ship to the other, causing her to reel in a most unpleasant way; and Mrs. Stevens will remember, I think, that we often used to sit in the saloon with the piano vertical over our heads, and I remember once that Mr. Stevens, who was a very good judge of the behavior of a ship, said to me: "I don't think she will reel over, but

it looks very suspicious." Besides the water ballast, the ship was subjected to other difficulties. Incidentally, the Sheriff had levied upon her as we were leaving the harbor, and we were detained one day at Staten Island in order to get rid of his affectionate attachment. For want of means the officers had been compelled to get what coal they could, and from any source where credit could be had, and so after the scanty supply of bituminous coal was exhausted, the fuel was limited to the stock of anthracite coal which some enterprising trader may have procured from Rhode Island. To the stokers, at least, it seemed to be absolutely incombustible, and very safe as a place of refuge in the event of a general conflagration. (Laughter.) There was not a stoker on board who had ever used anthracite coal or indeed had ever seen it, but if I am not detaining you too long (Cries of "Go on. Go on.") I will complete the story. The Captain, Sir James Anderson, came to us and said, "We cannot get along. We have burned up all the coal and that ——— (using a nautical phrase) that stuff we have down there won't burn. Can you tell me what to do?" So Mr. Stevens and I, old as he was, and younger as I was then, crawled down through many devious passages until we reached the boiler room and there found a very discouraged lot of people, who were trying to burn anthracite coal in the same manner as they would burn bituminous coal. Of course the fire went out, and you will be surprised to learn that he and I, and mostly he, spent nearly two days in the boiler room, teaching the stokers how to burn anthracite coal, which we succeded in doing and were finally landed at Brest. This is a simple illustration of the character of this remarkable man. I might give you innumerable instances of the interest which he took in all practical matters, but I am afraid you will think me an old and garrulous man (Cries of "Not at all. Go on."), so that I will bring these desultory remarks to a close with a single observation. The Stevens family of the last generation were creators as well as founders. You gentlemen, who have profited by the beneficence and foresight of Edwin A. Stevens are reaping the fruits of the seed which they in their day and generation sowed so abundantly. They were men of not only great sagacity and untiring energy, but of a high order of courage and fortitude. When Robert L. Stevens found

"PER ASPERA AD ASTRA." *

What are those stars by rugged path-way gained?
And what the road by which they are attained?
Those stars are the rewards, the crowns, the goals,
The final dwellings of heroic souls.
Of those whose life-long toil of hand and mind,
Was freely given to uplift mankind,
To gather knowledge and develop arts
To build up nations and make happy hearts.
Increasing comfort, lightening human toil
From conquered nature winning richest spoil;
Guarding the weak from the encroaching strong
Rewarding virtue and preventing wrong.
On such as these are starry crowns bestowed,
For such as these the stars are fit abode.
  Of the rough paths which lead to such rewards
Examples every noble life affords.
The Martyr gives his life, the Hero bleeds,
The Patriot strives with noble words and deeds.
The moral teachers and reformers give
Their lives of labor that the truth may live.
Students of nature work to age from youth
To bring to light some hidden gem of truth.
And countless laborers suffer, strive, refrain,
That from their work their fellow men may gain.
  Nor need we travel far to other climes,
Or instance heroes of the classic times,
To find examples fitted to inspire
Loving respect and emulous desire.
The name of Stevens calls at once to mind
Three lives of willing labor, which combined
Or singly, illustrate the upward road
Which straight ascends to that star-decked abode.
To affluence born, and tempted thus to give,
First thought to self and but for self to live,
Each one in turn, and all, this test withstood,
And gave their means and thought to general good.[1]
  The rapid steamer joining strand to strand,[2]
The yet more rapid train across the land,[3]
The iron rail on which the swift trains run,[4]
The shell adapted to the long range gun,[5]

* The motto of the Stevens family.

RAM ATTACKING VESSEL.

The iron-clad steamer ramming down the foe
With monster cannon loaded from below,[6]
Those links which bind the world with bands of peace
Those arms which in the end will make wars cease,
All these and many others, which have lent
So largely to the world's development [7]
Grew from the Stevens lives, so richly fraught
With liberal outlay and ingenious thought.
And at the last what can we fitly say
Of him whose latest work we hail to-day?
Who, as a closing act of such career
As we have painted, sowed the seed which here
We see developed into fields of grain
Loading with harvests many a distant plain.
Our Founder planted that which year by year
Has sent its fruitage outward far and near,
Till now there is no region where the sun
Uprising does not shine at least on one
Of Stevens' graduates doing useful work
In turning to good ends the powers which lurk
In force and matter, carrying far and near
The fair fame of the Stevens Engineer.[8]
And adding always to that special art
Which our good Founder had so much at heart.
For him the crowning stars long since were won,
For us they still are to be gazed upon.
Before *us* still extends the rugged road
Which must be climbed to reach the blessed abode.
On his example let us fix our eyes,
And following in his footsteps ever rise;
Scale each obstruction which our pathway bars,
And win at last our home among the stars.

NOTE 1. Charles King, President of Columbia College, writing of John Stevens in 1852 said—"Born to affluence, his whole life was devoted to experiments at his own cost for the public good," and the same may be said in substance as to his sons, Robert L. and Edwin A. Stevens.

NOTE 2. Robert L. Stevens was associated with his father in his early experiments in steam navigation from 1804 onward. In 1808 he himself took the *Phœnix* from New York to Philadelphia by sea, then for the first time navigating the ocean by steam, and, in 1811, with his father, he established the first steam ferry in the world between Hoboken and New York. "From 1815 to 1840 he stood at the head of his profession as a constructor of steam vessels in the United States, making innumerable improvements which were generally adopted." (Appleton's Cyclopædia of American Biography, Vol. 5, p. 671-5.)

NOTE. 3. In 1812, John Stevens urged the construction of a railroad on the line, and in place of, the afterwards constructed, Erie Canal.

In 1815 he obtained a charter for a railroad between Trenton and New Brunswick on the route joining New York and Philadelphia. This was the first railroad charter granted in America. In 1823 he secured the passage of Acts through the legislature of Pennsylvania incorporating the Pennsylvania R. R. Co. In 1826 he constructed a locomotive with a multitubular boiler at his own expense and ran it on a circular railroad on his own grounds at Hoboken.

In 1830 Edwin A. Stevens, with his brother Robert, obtained from the State of New Jersey the Charter for the Camden and Amboy R. R. and opened the road in 1832. This road they operated for many years and introduced numerous improvements since universally adopted, such as the T rail and the vestibule car.

NOTE 4. Robert L. Stevens devised the T rail in 1830 and went to England in order that by personal attention he might persuade some iron manufacturer to make it for the supply of the Camden and Amboy Railroad. In this, after much effort, he was at last successful at the works of Sir John Guest, in Wales, by personal superintendence, persuasion, and a guarantee against injury to the machinery.

The first shipment of these rails arrived at Philadelphia May 16, 1831, and over thirty miles were laid before the summer of 1832.

NOTE 5. Towards the close of the war of 1812, Robert L. Stevens was engaged in making a bomb that might be fired from a cannon instead of a mortar, and could thus be applied in naval warfare. With his brother Edwin, he succeeded in producing a percussion shell which was adopted by the U. S. Government, which purchased a large quantity of these weapons.

Their introduction, when general, was the end of wooden or un-armored war-vessels, the conclusive demonstration being furnished in the encounter of the *Merrimac* with the *Congress* and *Cumberland* in Hampton Roads in March, 1862.

NOTE 6. In 1812, John Stevens made the first experiments with artillery against armor and proposed to construct a circular armored vessel rotated by steam and thus training her guns. These experiments were continued in 1840 under his directions by his sons, until in 1841 they brought their results to the attention of the Government and after investigation by a commission of officers of the Army and Navy, an act was passed (April 14, 1842) authorizing a contract for an iron-clad steam vessel with plating 4½ inches thick. The vessel soon after begun, was continuously under construction and alteration for a series of years, the improvements in ordnance made from time to time requiring increase in the thickness of armor and, as a result of this, enlargement of the hull. Her guns, of the largest size, were to be depressed and loaded from below the armored deck. This feature was practically applied in a vessel rebuilt by Mr. E. A. Stevens and called the *Naugatuck* which did good service at Hampton Roads, and on the James River in 1863.

NOTE 7. In addition to the inventions and developments specifically mentioned or referred to, the following were among the subjects upon which the Stevens carried on useful and effective work.

The Patent law of April 10th, which is the foundation of the American patent system, was framed on the petition of John Stevens. (See the *Journal of the House of Representatives* for that year, p. 30.)

The multitubular boiler, which may be described as an essential element in all non-stationary steam-engines, such as locomotives and marine engines, was patented by John Stevens in the United States in 1803, and in England in 1805.

The forms of ferryboat and ferry-slip now in use, involving the overhanging guards, supported on brackets, and the use of "spring piling" and "fenders" were originated by Robert L. Stevens in 1821. He also invented the "cam-board cut-off" in 1818, this being the first application of steam expansively in navigation.

In 1821 he adopted the working (or walking-beam) and improved its construction by making it with wrought-iron straps and a cast-iron centre.

In 1826 he invented the split water-wheel.

In 1831 he invented the balance-valve, now universally used with beam-engines.

He was the first to place the boilers of steamboats on the wheel guards over the water, a practice universally followed to the present day in our river steamers.

He gradually increased the strength of the steam boilers, beginning with two pounds on the square inch until fifty pounds could be safely carried. At this same time in England the original low pressures were adhered to, so that in 1838 the *Great Western* carried only three pounds, and in 1846 the *Great Britain* carried only five pounds pressure per square inch.

In addition to the T-rail, to which reference has already been made, R. L. Stevens also invented the hook-headed spike (which is the railroad spike of to-day) and the "iron tongue" (which has grown into the fish-bar) and the bolts and nuts to complete the joints.

In 1850 he designed and built the *Maria*, the fastest sailing vessel of her day. This was the yacht which defeated the *America* in New York Harbor a few months before the latter won the memorable race against the English yacht squadron in the Solent. This was the race about which it is related that Queen Victoria, asking a sailor who was on the lookout for the vessels near the end of their course, which was leading and which came next, received the reply: "The *America* is ahead, the second is nowhere." This vessel, the *Maria*, was modified from time to time in her hull and spars by Edwin A. Stevens, but remained to the last the fastest sailing vessel of her time. She disappeared mysteriously in 1869, being, it is supposed, run-away-with and lost at sea.

Another evidence of the remarkable speed of the *Maria* was furnished during the visit of the Prince of Wales to America in 1860. Mr. E. A. Stevens,

THE MARIA.

then commodore of the New York Yacht Club, sailed down the bay in the *Maria* to meet the Prince, who was coming from Elizabethport to New York on his way from Philadelphia on the fast revenue-cutter steamboat, the *Harriet Lane.* Commodore Stevens sailed past the approaching steamboat, saluting and rounding to in her wake, proceeded to follow her up towards New York; but it was soon noticed that the *Maria* was fast overhauling the steamer and, in fact, soon passed her, to the profound surprise of all present.

Edwin A. Stevens invented and patented the Stevens plough, which was much liked and extensively used for many years; but his most notable invention was that of the air-tight fire-room, patented by him in April, 1842, and now in use in all the navies of the world.

NOTE 8. A classification of the Stevens Graduates made in November, 1895, showed the following remarkable record:

Out of a total of 551 graduates there appeared to be 148 who were superintendents and managers of the entire business of important machine shops and like engineering works. 54 consulting engineers carrying on professional work on their own account. 30 professors in engineering colleges. 55 assistant engineers or superintendents in work shops and like mechanical establishments. 16 presidents, vice-presidents, secretaries and treasurers of manufacturing companies. 103 employed, under superiors, in designing, drawing, and superintending the construction of machinery. 36 patent lawyers, solicitors, agents and inspectors for manufacturing companies. 8 superintendents of motive power on important railroads. 13 in the employ of foreign corporations. 6 editors of engineering journals. 3 architects. 4 chemists. 50 unknown or unclassified. 25 deceased. Among the unclassified should be mentioned one who, after graduation, turned his attention to Fine-Art and who has been for many years *hors concours* at the French Academy and received in 1893 the decoration of the Legion of Honor. This is Mr. Eugene Vail, who in a recent letter to President Morton says: "I take the keenest interest in the welfare of my 'Alma Mater,' and although my career has been so different from that of most of my classmates I shall never regret the four years spent at 'Stevens' or the training which has often been most useful in my after life."

In announcing the next toast,

THE IRON-MASTERS OF THE UNITED STATES.

"You should hammer your iron while it is glowing hot."

—*Publius Syrus, B. C. 43.*

The CHAIRMAN said: This is a wise saying of the old Roman, but sometimes it is hard to know when the iron is just exactly at the right heat, and how hard you want to hammer. In order to give us some information on that subject, I am going

to call on the most eminent and expert and successful forger of the United States. (Laughter.) Unlike some other gentlemen of this profession, who do not succeed in retaining the profits of their work, he has retained those profits and put them to the best use, as the steward of his Maker, that a man can put money to —the benefit of his fellow man. (Applause.) To which response was made by Mr. ANDREW CARNEGIE.

Mr. Chairman; Mrs. Stevens; Mr. President; Ladies and Gentlemen:

I have so often been benefited by the great past master of this country in iron and steel, your illustrious guest, Mr. Hewitt, that I wish to acknowledge to-night one more great debt for the beautiful, benefiting, elevating recital he has given us in regard to the Stevens family. I do not know how it impressed you, but I hope I do no discredit to the clergy when I say that I think there have been sermons that have given us less to think of and less to draw forth our admiration, than that which Mr. Hewitt has just delivered. Whilst he spoke, it seemed to me that this family preëminently demonstrated the supreme force of gentleness. Now the longer I live, the more I see that the real force, the real power, is not in the hasty word or the strong word. I know, when I try to write a thing, that if I am indignant or if I am enthusiastic, I use a strong word, (I don't mean a nautical one) but when I rub it out and put the gentlest word in that I can find, I have rendered that passage more forcible.

And so it is with the Stevens family. Our friend has depicted their lives. Now I have been thinking, while he spoke, that if he had just continued a little longer, as only his modesty prevented him from doing, he might have spoken of the monument that the Stevens family selected as the best means of perpetuating their name: and I say that the men who have selected a seat of learning—Harvard, Yale, Cornell, Cooper, Pratt, Stevens —these are the men who have chosen the means which will keep them in the history of their country and of the world longer and more prominently than any other means which a man can devise. (Applause.)

And more than this, they have chosen a living monument, with a soul in it—something that continues to perform useful

work, something which shows us that they desired more to benefit succeeding generations than to perpetuate their personal fame.

This, by way of introduction to the text upon which I am called to speak. Mr. Hewitt has shown you what the iron and steel industry of America was when he began. Contrast that with to-day. Instead of importing rails from England, we are this moment engaged in supplying the dear old mother land with that indispensable article. (Applause.)

Any celebration of this anniversary of Stevens would certainly be incomplete if a representative of the iron and steel industry were not permitted publicly to acknowledge his obligation to that Institute, to express his gratitude to its founder. You have only to look at your list of graduates and see the number that are now in charge of important enterprises, to know what Stevens has done. It is impossible to enter any of the great establishments without meeting a Stevens graduate. (Applause.)

But about England. I was talking about England just now. We had the Iron and Steel Institute here, as you know, a few years ago—some five hundred members. I was the chairman, and at a dinner at my house they drank my health in the English fashion. One of the leading manufacturers of Great Britain, a man whose career I have always watched since, because he has shown knowledge beyond any of his associates, said this: "We have seen all the establishments of your country, but it is not your improved machinery that we have reason to envy you. It is not your superiority in ores. No, it is something worth both of these combined. It is the class of young men that you can gather around you in your establishments. We have no corresponding class in England." (Applause.)

That man put his finger upon the preëminent cause of our [illegible].

And when the President of the United States was in Pittsburg [illegible] a library (Applause), I escorted him, and introduced [illegible] one after another of these young men, and finally [illegible] about the last man I had to introduce—I introduced [illegible] Schwab, Superintendent, and he turned around [illegible] "Why, Carnegie, you didn't introduce to me [illegible]" I said, "Yes, Mr. President, that is quite

true, but have you taken notice what kind of boys they are?" "Oh, yes; hustlers, every one of them!" That young man about whom the President made the remark is President of the Carnegie Steel Company at thirty-four.

But where do we get such boys? From Stevens. You can not import your institutions. They don't grow anywhere else. Some strange specimens may be seen from the universities. (Applause.) They are allowed to grow too long on the tree, and they are overripe; but to go in at the foot is what a young man must do in all great establishments where we have Civil Service promotion; and I could no more appoint my nephew or my son, if I had a son, than I could appoint—Mrs. Stevens, shall I say? No, when a man graduates, as Mr. Stevens did, at eighteen, from Columbia, and they are always explaining that he was a year late, or should have been—because I think it was Prof. Anson, or Sedgwick, that graduated at seventeen—there you understand the difference. The great value of Stevens is that it catches them young. You know what Doctor Johnson said about the Scotchman: it was wonderful what you could make of him if you only caught him young. (Applause.) Now, Stevens catches her boys young, and she sends them forth when they are still young, and that makes the success of so many graduates of Stevens.

I must not be supposed to undervalue the university for those who are trained for a profession. There it is necessary perhaps, that they should remain longer in these days than Mr. Hewitt did, or Prof. Anson or Sedgwick did, because I believe they are understood to know a great deal more than these professors did when they leave the university. No, the technical school, the university, the scientific school, all have their field. They are all working harmoniously to develop the higher powers of man, and it is a matter of congratulation to-night—I think everybody ought to congratulate everybody, and then congratulate himself, who has the slightest claim to the remotest connection with Stevens. (Applause.) I know Mrs. Stevens must congratulate herself, I know her family must, at this stage that we are passing through, and all this transition when even the clergymen begin to doubt Jonah and the whale, which has always puzzled me. I have

looked at this family to-night; I know what their thoughts must be. I see the tribute paid them to-night. They appreciate it. And after all, such a scene as this—you often find men going around and asking whether human life is worth living. It is a scene like to-night that always revives my faith and makes me feel like the old Scotch woman who stood for every one of the standards, even the doctrine of total depravity. She said it was as good as any of them, if you just lived up to it. (Applause.) The members of the Faculty, the President, the Trustees, the Alumni, the Undergraduates—every one, from the highest to the lowest, has reason to congratulate himself to-night. You notice that I put the trustees behind the President. My experience as a trustee in five colleges and universities is this: that if you have the right man in the right place as President, the trustees have nothing whatever to do; but whenever you have a President that don't know how to manage anything about the college, not even the trustees, then the trustees are sent for in solemn conclave and immediately resolve to set about finding a man who can manage it. So far as I know, I have not yet received a notice to attend any meeting to do anything on behalf of the Trustees of Stevens.

We can only hope, ladies and gentlemen, that the future of Stevens "will copy fair its past." If it does that, we can surely ask for nothing more, and that it will do so I have every confidence in the world.

And now for the Stevens family, let me end with the quotation that just occurs to me:

> "When force and gentleness play for a kingdom,
> The gentler gamester will the sooner win."

(Applause.)

At the conclusion of Mr. Carnegie's address, three cheers were given, at the proposal of Mr. Zimmerman, Class of '76, for Scotland and for the founder of the libraries in Pittsburgh, Allegheny, Braddock, Glasgow and Dunferline and the Music Hall in New York.

The next toast was

OUR IRON-CLAD NAVY.

In announcing the toast Mr. Dod said: I see your programmes have

"Illi robur et aes triplex circa pectus erat, qui fragilem truci commisit pelago ratem primus."—*Horace, Book I, Ode 3.*

And that this is said to be a translation after Dryden :

"Who safe upon the sea would ride,
With Harveyed steel must fence his side,
With live-oak backing fore and aft,
Taught by that 'cheese box on a raft.'"

Evidently a long time after Dryden. I also read "Omnia vincit Armor." * I have a copy which the President wrote out for me. In this copy it is not "Omnia vincit Armor," but "Omnia vincit Amor." (Applause.) And this is rendered, "Steel plates alone will keep out shot and shell," with the not inapt suggestion that the translation was supplied by the Harvey Steel Co.

As Americans, we are immensely proud of our White Squadron, whether parading in New York harbor, or blockading the city of Charleston. How glad we would have been to have them about thirty years ago, doing that same duty. Now we have here with us to-night a man who not only made possible, but actual, that White Squadron,—the hero of the Arctic ; the latest of the Doctors of Mechanical Engineering of the Stevens Institute—Commodore George H. Melville, Chief Engineer of the United States Navy.

Commodore MELVILLE responded as follows:

Ladies and Gentlemen :

The story of the life of three generations of the Stevens family is not only the story of the development of railway construction, and of steam navigation in this country, but it is the history of the early days of naval engineering, and of the first practical design of applying armor to the hulls of war vessels. It is also the story of the recognition of the importance of the mechanical and naval engineering professions. With the name of this family also will be associated the progressive advancement of the study of the Mechanic Arts and Sciences. And it is possible that the Institution of Technology, established as a memorial to the worth of these noble men, may be the Alma Mater of Engineers whose future work may influence, for even

* Note.—Virgil's Eclogue, 10.

a century, the trend of technical affairs in this great western land. (*Applause.*)

Closely associated with early railway operations, as well as with the beginning of steam navigation in this country, was John Stevens, the first of a family which has been prominent in engineering circles for a century. A man in advance of his time, he had the comprehensive intelligence to grasp the future possibilities of the steam motor. As one studies his character and life he is impressed with the fact that John Stevens had a clearer knowledge than any of his contemporaries, of the future revolution that would be effected in commercial, maritime, and naval affairs by the progressive development of the steam engine.

It has been a crime of the engineering profession that it has been too indifferent in securing due credit and honor for its professional achievements. The technical expert and scientist has been too backward in claiming the substantial rewards of his labor, and this lack of business efficiency has always stood in the way of his official, financial and social advancement.

The legal and medical fraternity have each established a code of ethics which secures to its members and to the profession the reward of individual labor. But the engineer has too long been content to build the foundation, and even the structure of great inventions, and then permit others to claim the rewards which should accompany his work.

John Stevens was one of those engineers whose labor has never received due official recognition, and a duty devolves upon some one connected with this Institution or State to show forth the value of Stevens' services to the development of railway, marine and naval engineering. He did possess business efficiency, however, and the competence which he secured was a tribute to his success in commercial matters.

The work that he projected, and which he carried on under discouraging conditions, shows that he was one of the first men in America to recognize the fact that gunpowder and steam are the two great exponents of modern realism. As a distinguished author has declared—"Gunpowder smashed the armor of the

RAM APPROACHING ENEMY'S FLEET.

knights, and banished the weapons of poetry and legend, but steam did more, for when it disclosed its power to man, it sent the days of romance whirling into a seemingly remote past." In devising his iron-clad steam battery, a vessel which was to outstrip the fastest sailing vessels of the day, Stevens saw that an armor clad ship thus propelled by steam would conquer all enemies and secure his native land from all attacks.

As was also the case with Robert Fulton and other engineers, John Stevens had a difficult task to install the marine engine even as an auxiliary in ships of war. With his prophetic eye, he must have clearly seen that naval vessels would develop into fighting machines rather than into fighting ships. It was plain to him that the time would soon come when the efficiency of the war vessel would be as dependent upon the technical training and mechanical skill of the engineer, as upon the maritime knowledge and readiness of resource of the sailor. He must have known, and yet his relations with the conservative government officials would not permit him to assert, that the steam engine would become a naval weapon. The sailor-officers had recognized the fact that gunpowder had ended the work of the Boarders and Pikemen, but they resisted to the utmost the inevitable passing of the top-gallant and royal-yardmen.

Fulton and Stevens knew that artillery in its early history had to fight its way for recognition as a weapon, and that the champions of the steam engine would encounter the bitterest of opposition. For centuries the broad-shouldered men-at-arms scouted the use of machine guns. The early artillerist had a status inferior to swordsmen and spearmen, and they were not regarded as the military equal of the sturdy-bowmen and powerful battle-axe-men. For at least two hundred years after the introduction of gunpowder the artillerists strove against prejudice as strongly as they fought against blood and iron.

The triumph of the engineer over prejudice and tradition has been comparatively rapid, for it required but fifty years to make steam the principal motive power on board warships ; but official recognition has not yet been given to the engineer and his work. The attempt to deprive him of a just share of the rewards of his service has impaired the efficiency of the organization, and

has caused internal strife, which is to-day our great naval weakness, and whose continuance invites disaster in time of battle.

In the quiet of his home and the quiet of his sleep, John Stevens passed away, and then Robert L. Stevens undertook the work of developing his father's idea of constructing an armored steam battery. The contest between armor and the projectile waged fiercely in 1842, when the Congress passed an Act authorizing the Secretary of the Navy to enter into a contract with Mr. Robert L. Stevens, "for the construction of a war steamer to be built principally of iron upon the plan of the said Stevens." About this time also appeared upon the scene the great Swedish engineer John Ericsson, who, failing to gain recognition from the British Admiralty, left that country in disgust and came to the United States. Ericsson undoubtedly crossed the Atlantic at the instance of Captain Richard S. Stockton, U.S.N., and he had, for some years at least, the moral, if not the official support of men high in favor at the Department.

The wrought-iron gun of English manufacture, which Ericsson brought over, was undoubtedly able to pierce the plates of the projected Stevens battery, but Robert L. Stevens was not ignorant of the possibility of hardening iron and steel surfaces, and if the officials of the Navy Department had not become dismayed at the improved ballistic qualities of the gun, Stevens would have shown that a corresponding advance was also possible in the means of defense, by making improvements in the arrangement and character of the armor plates. Officials too hurriedly decided then, as have experts several times since, that the projectile would always be in advance of the armor. As a result of this belief, official interference with the plans of Stevens became so persistent that his work was interrupted to such an extent, that the project languished until 1854, when work upon a modified battery was begun in earnest.

In 1856 Robert L. Stevens rested from his labors. Like his gifted father he was in advance of his age. Before the arrival of Ericsson he had shown that armor was in advance of the gun. As he recognized the fact that there had been a development of the weapon in England, he surely would have met this advance

by designing an improved quality of armor, if conservative officials would have given him the opportunity.

As one carefully studies the plans of the floating steam battery, it is clear that Robert L. Stevens saw through the veil that intervened between his day and the future. He knew that his talented brothers, or at least a third generation of the Stevens family, would witness the departure of the old sailing fleets, and then would come a new navy whose squadrons would be composed of ships that would be veritable floating machine-shops, filled with complicated and crowded appliances. As he worked night and day upon his plans of an armored ship, he must have seen that with the coming of the 20th century there would be a change in the construction of warships, and that there would be a revolution in the organization of the personnel.

Engineers like Stevens must have realized that this revolution in naval affairs would result in strengthening the power of the enlightened nations, and that the change from sail to steam would be followed by a higher civilization. (Applause.)

The aged sailor of a previous generation also had a vision of a new era, and as he saw that the passing of the ships of oak would end the romance of the sea, the ancient mariner must have thus mused: "Gone are the sheets and braces, and the boatswain's pipe, 'Haul taut mainsail haul.' Gone are the fleets which gave Nelson and Lord St. Vincent their great victories. Gone are the majestic line of battle ships with their mass of bright-work, their seas of snowy canvas and their tier of gun decks. Gone are the swift frigates with their lofty masts and heavy yards. Gone are the handsome corvettes, the trim little sloops, and [illegible] the pert brigantines, and the saucy and [illegible] schooner yachts. But saddest of all to the sailor—gone are the days when Nelson saw his young lieutenant gamboling and climbing his own bowsprit or aloft, maybe with a marlin-spike [illegible] round his neck showing an example to his men."

There came with the naval engineer the civilizing influences of the [illegible] of steam and with each successive advance in the construction of a higher type of engine and steam generator, there has been a progressive improvement in the character and intelli-

gence of the crew. And therefore with much joy, not only the engineer but the world can say : Gone are the days when the captain of a warship was an absolute despot, and when naval crews were composed of desperate men, who, in the opinion of the sailor officers, could only be made amenable to discipline by being flogged into shape. Gone are the brutal days of the lash, which was supposed to be a necessary concomitant of a war vessel. Gone are the days of the press gang when it was found necessary to recruit crews from prisons and penal settlements.

The bright fancies which Stevens pictured were far different from his experiences in the attempt to do a great work for his country. While semi-official encouragement was given Ericsson, distrust and opposition were encountered by the various members of the Stevens family in their effort to induce the Navy Department to deal justly with them in the construction of their armored vessel. In 1861, Edwin A. and John C. Stevens offered to complete the projected battery at their own expense if the Government would reimburse them for the ship after its usefulness and efficiency had been successfully shown. The country at that time was sorely in need of armored vessels, and the officials of the Navy Department were giving patient hearing to designers who came along with any new type of armored ships. It mattered not that the Stevens family had been successful in various railway and shipping enterprises, and that they had been identified closely with every success pertaining to the introduction of steam for navigation purposes. The naval vessel proposed by them contained too many machines, and it bore too many evidences of the forge and the foundry, rather than of the sail loft, to suit the traditions of the sea.

In a marked degree the whole Stevens family possessed grit, for at their own expense they fitted out the steamer *Naugatuck* with their arrangement of protective armor and loaned it to the Government. By reason of the bursting of her Parrott gun the armor of the *Naugatuck* was not subjected to a desired test, and the value of the design of Robert L. Stevens could not be impressed upon the navy officials of that period.

The experience of all countries during the past century conclusively shows, that there are people who will condemn systems

of naval construction because auxiliaries are defective which have no relation to the general plans. In this generation we have become wise enough not to reject the system because mishaps have occurred to some details during the course of construction. It would have been fortunate for the country if the invention of Stevens had been judged upon its merits, and not from the standpoint of tradition and prejudice. The engines and boilers of the Stevens Battery were the equal in design of anything then afloat, and it is fair to presume, that an engineer of the varied experience of Robert L. Stevens had provided for armor the superior of which had not been manufactured. The vessel came too near being an engineer's ship to suit the sailors of that period, and therefore reasons were looked for why such an armored vessel should be condemned, rather than why she should be taken into the navy.

From 1854, when work on the armored vessel of Stevens was begun in earnest, the designers had a battle royal with the officials of the Navy Department. If it be true that the blood of the martyrs is the seed of the church, then the injustice heaped upon the Stevens family eventually resulted to the benefit of the naval service, and possibly to the safety of the nation.

Without detracting in any manner from the genius or glory of Ericsson one cannot but believe that had the Government completed the ship designed by Stevens, the fate of the *Merrimac* would have been sealed before she sank the *Cumberland* and set on fire the *Congress*. It must not be forgotten that the contract for the *Monitor* was not signed until September, 1861, while work on the Stevens Battery had commenced seven years earlier. That Ericsson worked independently of Stevens cannot be controverted, neither can it be doubted but that the energy and persistency of Stevens so educated the minds of the officials to the value of armor that they were thus able to comprehend some of the advantages of the monitor and other types of protected vessels.

The conversion of the *Merrimac* into an iron-clad battery was undoubtedly an outcome of Robert L. Stevens' suggestion. It is peculiarly significant that the term "battery" was used by the Confederates in connection with the changes that have been made to this first-class frigate. In the specifications submitted

by Ericsson for the construction of an iron-clad steamship, he speaks of "a floating battery." The Naval Board appointed to examine carefully all plans submitted to them in 1861 for the best type of iron or steel clad war vessel, also uses the term "steam battery." In his controversy with the government officials, Stevens undoubtedly hammered the word "battery" into the vocabulary of these men in describing an armor-clad floating fortress.

The modern battle-ship is only a development of the plans of Stevens and Ericsson. There have been improvements in armor, armament, machinery, and methods of naval construction. The advances, however, have been due in great part to the increased efficiency and capability of machine tools, and herein again has the world been indebted to the work of the mechanical engineer.

As the student beholds the difference between the new and the old navy, and remembers that "Destinies change as fleets change," then he must believe that, Watt, Fulton, Stevens and Ericsson, rather than those who have commanded Britannia's fleets made it possible for England to secure her present maritime supremacy. (Applause.)

Our naval commanders of the past century bequeathed to this nation predominance on the ocean, a predominance which was lost in the transition from the sail to the steam age. This inheritance will yet be reclaimed, but it will be secured as much by the work of the engineer as by that of the sailor. And if the national government will permit the scientific colleges to send forth the elect of their graduates to compete for commissions in the naval service, then it may be that the genius of the engineer graduates of such institutions as yours will bring about the restoration of that command of the sea which our people have too long been dispossessed of. (Applause.)

The Navy owes much to the Stevens family, and as an officer of that service I am pleased to pay an humble tribute to the importance of the work accomplished by them.

That a memorial should be erected to the work of John, Robert L. and Edwin A. Stevens, is more than fitting. The day will yet come when the Congress of the United States will give some official recognition of the work rendered by these men. The engi-

neering profession should also give expression to the value of their services, for the successes of this family are closely identified with the progressive advancement and development of mechanical engineering along all its lines.

In founding and sustaining a school for the development of the Mechanic Arts and Sciences, the various members of the Stevens family have honored their ancestors, and established the best memorial that could have been devised. It was appropriate also that the institution should be established at that place where the work of the Stevens family had been carried on.

That graduates will go forth from this Institution, who will be leaders along various engineering lines, can surely be expected. By their work these young men should show that not only the benefactions of the founders and patrons, but the services of that early Faculty and their successors are appreciated; for with judgment and discriminating knowledge were selected the educational staff, and as a result, the work of this school has given a prominence to Mechanical Engineering which the science never before possessed.

Much will be learned by those who enter your walls, but no better lesson can be taught by the Faculty than this: That in striving to attain the success that had been achieved by those whose energy established this Institution, the students should also emulate their patrons' devotion to duty, nobleness of character, and love of country. (Great applause.)

The next toast

AMERICAN CITIZENSHIP.

"Non sibi sed patriæ."—[illegible]
Not for "boodle," but for general good.
[illegible]

was then announced by the CHAIRMAN, who added:—

I think this whole assembly, and not only this whole assembly but any assembly that we might gather within the limits of this great metropolis, will agree with me that it is hard to find in character or conduct, whether amid the homes of the wealthy or the tenements of the poor, whether in the discharge of his

high and holy calling or of his civic duty, a more splendid example of that noblest conception of humanity, the truehearted American citizen, than the one whom I will call on to respond to this toast—the Right Reverend Bishop Potter, of New York, whom we all know. (Applause.) In responding, Bishop Potter said:

Mr. Chairman ; Ladies and Gentlemen :

If I could state to you the hour of the night, and the infrequency, after twelve o'clock, with which the boats run to Hoboken, I am satisfied that, as is the habit of the Congress of the United States, you would give me liberty "to print," and spare you the hearing of any words from me.

And yet there are certain aspects of the subject which have been assigned to me by my most kind friend, the Chairman, concerning which I should like, if I may, to say a word to you, and that because of certain personal relations to them, which I presume are unknown to most of you.

I was very much impressed, being, like himself, what may be called "a frequent trustee," with the description which Mr. Carnegie gave of the relation of a body of trustees to a successful institution of learning or letters. I have long ago learned that if we have a "live man" at the head of the institution, the trustees perform (possibly Mr. Carnegie and I would venture to claim) an ornamental service in its general progress, but not much more. But I submit to him that that is in accordance with the very highest law. One of my clergy told me, not long ago, that he had been sent for some months previously to conduct what is called a mission in the Bermudas, principally among the colored people. He found there, among other members of the congregation to which he was missioner, a colored woman who had been much disturbed in her domestic relations, because of the uncertainty of her husband's affection, whether for herself or for somebody who lived on the next plantation. After having attended the whole series of services, she said to the parson that she had succeded in impressing her husband with the thorough inconsistency of his conduct with the teaching which she had heard at the mission. Said she, "Now, Tom Johnson, you have got to behave yourself. For the parson said that the good book says that '*no man can serve two masters.*'" That applies to an

[illegible] you are called [illegible] shall go [illegible] consciousness [illegible] merely to con- [illegible] take [illegible] world [illegible] and [illegible] character [illegible] the [illegible] communi- [illegible] commemorate and to honor. [illegible] together [illegible] calling. [illegible] [illegible] questions which [illegible] applause.

The [illegible]

THE [illegible] AND [illegible] OF THE [illegible]

[illegible] settlement [illegible]

[illegible]

[illegible]

[illegible] towns [illegible].

[illegible]

The [illegible] miles an hour [illegible] was [illegible] thousand miles [illegible] miles an hour [illegible] going [illegible] questions will be best answered [illegible] National Museum [illegible] Department of [illegible]

[illegible]

[illegible]

[illegible] the presence [illegible] which [illegible] this [illegible] sense [illegible] and [illegible] I will [illegible] myself to a few [illegible] the great services rendered by these [illegible]-

guished Americans, a father and his two sons, in solving the problem of steam transportation early in the century.

In measuring the progress of the human race, we are accustomed to associate the name of some one person with each of the great epoch-making inventions. Although this is neither the time nor place to consider the claims of rival inventors to distinction, I can not even briefly discuss the theme upon which I have been invited to speak without calling to your attention some facts which have come to my notice in the course of the efforts made to preserve the history of the steamboat and railway in the Smithsonian Institution at Washington.

Over a century ago, in 1792, John Stevens of New Jersey, took out a patent in the United States to propel boats by steam. He experimented continuously until 1804 when he invented and constructed the first steamboat, to navigate the waters of any country, driven by a screw. A model of this twin propeller boat belonging to the U. S. National Museum is before us. The original machinery is also at Washington.

This boat was successfully operated three years before Fulton obtained fame and fortune by putting his English engine, built by Watt, in an American hull, afterward called the *Clermont.*

During the weeks that Fulton was at work on the strange looking craft which caused wonder to the inhabitants of the Hudson Valley, John Stevens and his son Robert were engaged in building a well designed American boat with an American engine—the *Phoenix*, which in 1803 was the first steam vessel to navigate the ocean, when it made the voyage from Sandy Hook to Cape May, conveying its crew from New York to Philaphia on the first journey made by steam between those two cities.

The brief time assigned to me will not permit mention of many other triumphs as steamboat constructors which John Stevens—and especially his son Robert achieved. For fifty years, from 1806 to 1856, when he died, Robert Stevens, in addition to other important work, continued to experiment with and improve the American steamboat. During the latter part of his life, he was recognized both at home and abroad as the foremost American Naval Architect. Had he done nothing else, his fame would

[illegible] years
[illegible] the historic Hud-
[illegible] notwithstanding the art of great
[illegible] which [illegible] followed later
[illegible] the general plans
[illegible] a century ago.

[illegible] the problems
[illegible] Stevens [illegible] told me
[illegible] believed in the
[illegible] worked upon
[illegible] patent during
[illegible] difficulty was [illegible]
[illegible]

[illegible] Stevens was [illegible]
[illegible] and several
[illegible] In the early
[illegible] Company [illegible]
[illegible] the road
[illegible] almost
[illegible] the
[illegible] Company.

[illegible]
[illegible] expense the
[illegible] the Western
[illegible] John Stevens
[illegible] a track
[illegible] the Institute
[illegible] the
[illegible] Stephen-
[illegible] the "Rocket."

The Camden and Amboy Railroad Company, the greatest railway of its time, was a monument to the skill and energy of John Stevens and his sons. The rails for this great iron highway over which all of the traffic between New York and Philadelphia was conducted for many years, were designed by and rolled under the direction of Robert L. Stevens—and the American rail with a base—the type now in universal service on this side of the water, was solely his invention. After a controversy of many years this fact has lately been proved by documentary evidence.

Thus far I have not had the occasion to speak of another son upon whose munificent bequest was founded the great Institution for the Education of Engineers, whose Quadro-Centennial Anniversary we are to-night assembled to celebrate. Situated upon the shores of the Hudson, it overlooks the scenes where for over a half century John Stevens and his sons zealously toiled in their efforts to solve the great problems of steam transportation on water and on land.

Overshadowed by the genius of his distinguished brother, eight years his senior, who afterward made him his legatee, it is not to be wondered that the fame of Edwin A. Stevens does not stand out in such bold outline. But to those familiar with his career it is plain that the individual work of these two brothers should not be separated.

Edwin was only a boy when his brother Robert made his early improvements in steam navigation, but later he rendered him valuable assistance. His most notable individual invention was the air-tight fire room, patented April, 1842 (No. 2,524) and now in use in all the navies of the world.

As the famous Stevens battery, in the construction of which from 1842 to 1870 many thousands of dollars were expended, (over a million dollars being bequeathed to it by Edwin Stevens) does not come within the compass of my subject, I will only say of it that the plans for the construction and modification of this leviathan of the deep embodied ideas which, although not approved by our naval officers in those earlier years on account of novelty, have since been found practicable and necessary in an iron-clad ship of war.

Beginning with 1825, when he first associated himself with the Union line, and 1830, when he became manager of the Camden and Amboy Railroad Company, Edwin Stevens was known throughout the land as the ablest of railroad officials.

He summoned great lawyers to his counsel to aid in settling legal questions concerning right of way and other privileges necessary for a railroad. At that time the processes now in vogue were antagonistic to the common law of highways. As an organizer and administrative officer, he was without a peer. He called to his side competent business men, able mechanics and reliable contractors; legal objections were thus promptly met, the right of way secured and the great railway built and put in operation in an incredibly short time.

Edwin Stevens was General Manager of the Camden and Amboy Railroad for upwards of thirty-five years, during which time the stock constantly appreciated in value, and not one dividend was passed.

It was within this formative period that the American railroad system, differing materially from that simultaneously developed in England and on the Continent of Europe, came into existence. Our system differed from theirs, in the method of running trains safely on less substantial tracks, not inclosed; in the long passenger coaches with inter-communication between them and equipped with "bogies" or trucks; in the increased weight, strength, and capacity of our rolling stock, and in the simplicity and greater hardihood of our locomotives constructed for roads with many curves.

In the development of this American system, Robert and Edwin Stevens were most prominent, inventing and constructing many of the appliances in use for many years.

It can be said without injustice to other Americans distinguished in similar lines, that John Stevens and his sons, through their labors in the field of experimental mechanics, were able to obtain more definite information relating to steamboat and railway engineering than any of their contemporaries.

The laws which they laid down are now so well understood that few know, or remember, that it is to them we are indebted for the most valuable data used in modern engineering practice.

Every railway train bearing hence the products of the fertile West is aided in reaching this metropolitan city by the use of one or another of the appliances invented by John Stevens and his sons many years ago—while the design of every steamship that sails from this superb harbor is in some measure based upon the experiments made by these great engineers when steam navigation was in its infancy.

I know of no other instance in which so great material benefits have been bequeathed to the human race by the exertions of a father and his sons.

I congratulate the Stevens Institute of Technology upon having for its founder a man not only of wealth, but of inherited ability! I congratulate the Trustees, President, and Faculty upon twenty-five years of success in carrying out the terms of the bequest which enabled them to rear and maintain so fitting a monument as that noble Institution overlooking the river and harbor where steam navigation had its birth and steam locomotion dwelt in its infancy! I congratulate the Alumni upon the places of honor and influence they occupy among Engineers! I congratulate the undergraduates upon the opportunity given them by the munificence of Edwin Stevens to emulate his worthy example! But above all I congratulate every American upon the fact that so early in the history of this Union we had among our countrymen steamboat and railroad engineers so distinguished both at home and abroad as John Stevens and his sons!!!

After the applause following Mr. Watkins' address had subsided the Chairman said he would pass over the next toast, "Our State," owing to the absence of Gov. John W. Griggs, who was to respond to the same, and called for the next toast.

THE ALUMNI.

> "Nulla dies sine lineâ."
> No day passes that they do not develop in some new line.
> "Nec scire fas est omnia."
> Even a Stevens graduate does not know everything.
> (*Trans'ated by an admirer.*)

They are described on the bill of fare as Oyster-openers, the world being their oyster. I understand that the President of the Alumni Association is diligently engaged in opening western oys-

ters. Let us hear from him as to his success in that enterprise. (Applause.)

Mr. Chairman, Ladies and Gentlemen:

For some reason, unaccountable, except for the fact that I am a resident of Ohio, you, who are members of the Alumni Association have elected me President, and I have the honor to speak for you on this memorable occasion, but, boys, you will regret it.

I have received two invitations to speak to-day, one at an Insane Asylum, the other, here, and when I have finished, you will not wonder at the invitation first mentioned.

A prominent engineer recently expressed surprise at learning that Stevens was only twenty-five years old; surely this is flattering, and is a proof that, in the language of the text given me, "no day passes that they do not develop in some new line." Electric, Steam, Water, or Gas line, it makes no difference, the Stevens man gets the "pull" on the line, and it should be noted that he does not hang himself with the slack.

You may not know that the reputation of one Stevens man for being "up to date" caused, for him, a serious misapprehension. Whilst off on a trip to obtain contracts, he stopped for a few days at a summer resort. Being a Stevens man, he was, of course, warmly received. All went well until one fair damsel noted a package sticking out of his pocket labeled "Blank Proposals"; this was too much, even for the Bar Harbor girl. After all, too many lines out is not wise in such matters any more than in business. It is wise to specialize; not only is it best for the individual but it has, I believe, been one element in the success attained by Stevens.

Whatever is helpful to Stevens men, helps Stevens. Stevens gave us a start, it is our wives who have continued the education. Let us give thanks to Stevens; let Stevens give thanks to our wives; who can give thanks to us?

I will tell you, Stevens boys of the past and future, our profession, and the community at large will be thankful to us if we do just one thing—act honestly. Dishonesty is one of the worst evils of the times. It is not a sufficient excuse to say that "others do so and so," or that "our profession is as free from dishonest practices as any." Do not accept any considerations

in business matters to which you are not entitled as a right. Not only do not receive bribes, no matter how seductively they are offered; no Stevens man would do that; but do not give bribes. Be honest with your employee, with contractors, and with your client. Give honest advice and honest expert testimony.

A lawyer friend of mine paraphrased a well-known description of the three kinds of liars into "liars, lawyers, and technical experts." Recently I saw the statement that Mr. A. was the most credulous man in existence; he actually believed a technical expert. Do you feel flattered by such jokes? Do you believe that every man has his price? I certainly do not. I feel strongly on this subject, and I sincerely believe Stevens men should not only be honest, but should fight for honesty, and discourage dishonesty in contractor, employee, or client.

It is not necessary for me to elaborate on the second text given me, which, you will note, is to the effect that not even a Stevens man knows everything. If it were not for one thing I would attempt to refute the statement; but, boys, too many of you have brought your wives, they know your limitations.

There is one thing which, I am sure, we all know; it is that to the founder of Stevens, and to those who have given freely of their time and means, we owe a debt which never can be repaid; but it should not be considered as a burden any more than in our family relations we consider it a burden to be indebted. Let us, as working members of the Alumni Association, try to help Stevens, not only because we ought, but because we wish to. Not less are we indebted to our honored Faculty and to our beloved President, who are all, thank God, still with us. Let them know that our hearts are warm toward them; let us not wait to pass resolutions, after their death, but praise them now, and may the day be far distant when a vacant chair at Faculty meeting indicates that one of them has gone from us.

This evening will always be present in our memories, and, when the fiftieth anniversary is celebrated, may our Alma-Mater and her younger sons say of those of us who have gone—and let us give them a right to say it truthfully, and as a synonym of all

that is helpful, manly and honest—he was a true Stevens man.

The CHAIRMAN then announced the final toast,

THE FACULTY.

"Docendo discimus, sed non omnia possimus omnes."—*Virgil.*

We learn by teaching, but not fast enough to keep up with the examinations for admission.

(*Translated by a candidate for admission.*)

In calling on President MORTON to answer to this toast, the Chairman asked his permission to read the following letter which he had received from him a few days since.

S. BAYARD DOD, ESQ.,
PRESIDENT OF BOARD OF TRUSTEES OF THE
STEVENS INSTITUTE OF TECHNOLOGY.

Dear Sir:

I send you herewith certificates for one thousand shares of stock of the Texas Pacific R. R. Co. which I desire to present to the Board of Trustees, to be held until their appreciated value, with such other funds as may be devoted to that purpose, may be adequate for the erection and maintenance of the proposed new building generally referred to as the "Alumni Building."

I have put my gift into this particular form as an example or suggestion to others having the interests of the Institute at heart, that they might, when able to do so, present to the Institute some form of property having a prospective value in advance of its market price. Such, for example, as the stock of newly organized or reorganized companies of a substantial character.

The needs of the Institute are rather for the future than the present.

Her work, as heretofore and at present conducted, can be carried on with the means already in her hands, but for the extensions which should be made in the future in order that she should maintain her leading position, larger accommodations and increased revenue will be required.

There are also many cases in which our Alumni or others could donate to the Institute property of prospective value, where

they could not withdraw from their resources cash or that which yielded immediate income.

With best wishes for the Alma Mater, whose Silver Wedding we are about to celebrate, I remain,

Very truly yours,

HENRY MORTON.

Allow me to say, in connection with the subject of this letter, first, that as most of you know this is not the beginning, as I hope it will not be the end, of Prof. Morton's liberal contributions towards the needs of the Institute, and, second, that his good example in the past has been followed by every member of the Faculty, each of whom has, according to his means, contributed to the fund which is in course of collection for the erection of the new building referred to by President Morton in his letter, in addition to many contributions towards the special needs of their several departments.

In doing honor to our Faculty, therefore, we are honoring men who have proved themselves worthy followers of our Founder, not only in the devotion of their lives and intellectual powers in forwarding the cause of Engineering Science in its practical application, but have also followed his example in contributing of their means toward the same good work.

President MORTON responded as follows:

In rising to speak at this late hour, allow me to quote something that I heard and that impressed me very much, on a similar occasion. I fully sympathize with the state of feeling that must exist on the part of most of my audience, and will therefore be very brief; that state of feeling being such as attends the late hour or the next morning—that which is so vividly described in Bunyan's "Pilgrim's Progress" as the contest between Christian and Apollinaris.

That I may not be led to any undue length, I have written out a few points that I desire to make, which will occupy not more than three, or at the outside four minutes, I am sure.

REMARKS OF PRESIDENT MORTON IN REPLYING TO THE TOAST "THE FACULTY."

Let me explain at the outset that in answering this toast for

the Faculty I am speaking for an ideal body, not for myself and colleagues of the present time, but equally for the Faculty of the future and the Faculty of the past. In fact, this Faculty which I desire to represent is like Truth immortal and will exist in an ever improving embodiment long after all its present constituents have passed away. Regarding the Faculty whom I represent in this individual and yet impersonal way, I may be allowed to say of it some things which the modesty of its members might forbid my uttering if I were assumed to speak as their mouth-piece only.

In the first place I would say, that the youth of this Faculty has been a healthy youth of struggle and effort involving something of hardship. It has not been after the manner of the *jeunesse dorée* of some institutions endowed with many millions and needing but to express the wish for any appliance or tool, desirable for carrying on its work, in order to have it. This young Faculty has had to content itself with plain tools and rather a minimum of appliances, and has frequently provided needed tools for itself while carrying on its work. And let me say here that this statement is not limited in its application to any one individual, but it is true in proportion and degree for each and all.

The best of workmen cannot turn out good work without any tools and the best of tools will not make good work for the poor workman, but the good workman with the best tools will turn out a maximum of the best work with the least exhaustion of his capacity for its production.

I by no means intend to say or suggest that our Faculty in the past and present has not had or does not have good tools. The product it has turned out speaks for that ; but I do desire to place on record in this connection my conviction that the Faculty of the future in view of the greater demands which will be made upon it, both as to the quantity and quality of its product, will need more space to work in and more appliances with which to do its work.

I have no anxiety as to the needs of to-day, but looking into the future I am solicitous that timely provision should be made for its needs.

This Faculty, beginning with eight members, now numbers

twenty-two, the additions, without exception, being the intellectual children of the first eight, and though this has been a united family with no disputes tending to make the house too small to hold it, yet it is easy to realize that with all which has been done in the way of adding wings and new stories, the old house cannot continue forever to accommodate its increasing population.

As to the work done by our present twenty-five year old Faculty I need say nothing.

If it did not speak or has not spoken for itself to-night, any words of mine would be inadequate: What I hope is that in the near future, some one, or many individuals, possessing the ability and looking at the past work of this immortal Faculty, will say in the words of the parable:

"Well done good and faithful servant, thou hast been faithful over a few things, I will make thee ruler over many things."

For myself, I am well aware that the time is not distant when I must lay aside a work which has never been a labor but always a pleasure, except on the rare occasions when I have been obliged to affect an uncongenial severity in repressing some excessive exuberance among our Undergraduates, but I am solicitous that my successor should be duly equipped with the means required to meet the more stringent demands of the future.

Three enthusiastic cheers were given for President Morton at the conclusion of his address, and then

The CHAIRMAN stated that the President of Stevens Institute, besides being able to make machinery hum and play the "Anvil Chorus," can also give us something else.

We shall now listen to a song, the words of which are by President Henry Morton (what can be more thoroughly inspiring than that name?), and the music by Frank L. Sevenoak, and the performance by Stevens men, and the subject "Stevens Men." (Applause.)

Several verses of the song which is given below were then rendered by members of the Stevens Glee Club, Dr. Sevenoak and Mr. Wm. H. Ives of the Stevens School assisting.

At the conclusion of the exercises, cheers were enthusiastically given for Mrs. Stevens.

A list of the guests present follows:

Mrs. M. B. Stevens,
Mrs. Archibald Alexander,
Mrs. Jno. Stevens,
Mrs. Henry Draper,
Mr. Andrew Carnegie,
Mr. Chas. MacDonald,
Chancellor and Mrs. McGill,
Mr. Abram S. Hewitt and daughter,
Bishop and Mrs. Potter,
Dr. Chas. Chandler,
Mayor and Mrs. Fagan,
Director P. C. Ricketts of Rensselaer Polytechnic Institute,
Chancellor and Mrs. McCracken,
Commodore Geo. W. Melville, U. S. N.
Mr. J. E. Watkins, Curator Nat. Museum,
Mr. Wm. Keuffel,
Director R. H. Thurston, Sibley College, Ithaca, N. Y.,
Mr. S. B. Dod,
Miss Lewis,
Mr. and Mrs. Richard Stevens,
Col. and Mrs. E. A. Stevens,
Mr. and Mrs. A. L. Riker,
Mr. L. H. Hyde,
Mr. Geo. R. Turnbull,
Mrs. Boyd,
Miss Turnbull,
Mr. and Mrs. Chas. Albert Stevens,
Mr. and Mrs. J. M. Wilson,
Mr. J. C. Browne,
Mrs. E. P. Gibson,
Mr. Jno. T. Gibson,
Mr. Jas. A. Hayden,
Miss Hayden,
Miss Hayden,
Dr. F. L. Sevenoak,
Mr. E. A. S. Lewis,
Mr. Wm. H. Ives,
Mr. Adolph Kutroff,
Mr. A. B. Farquhar,
Mr. and Mrs. J. C. Kelly,
President and Mrs. Morton,
Prof. and Mrs. A. R. Leeds,
Prof. and Mrs. Chas. F. Kroeh,
Prof. and Mrs. DeVolson Wood,
Prof. Edward Wall,
Prof. and Mrs. T. B. Stillman,
Prof. J. E. Denton,
Prof. and Mrs. A. R. Lawton,
Prof. and Miss Graydon,
Prof. J. B. Webb,
Prof. Wm. E. Geyer,
Prof. A. Riesenberger,
Prof. A. F. Ganz,
Prof. F. D. Furman,
Prof. Wm. H. Bristol,
Prof. D. S. Jacobus,
Henry W. Post, '74.
Wm. Hewitt, '74.
F. M. Leavitt, '75 and Mrs. Leavitt.
A. P. Trautwein, '76.
A. R. Wolff, '76 and Mrs. Wolff.
Wm. Kent, '76 and Mrs. Kent.
G. C. Henning, '76 and Mrs. Henning.
Wm. F. Zimmerman, '76.
P. E. Raqué, '76.
Jas. M. Cremer, '76.
E. P. Roberts, '77.
L. H. Nash, '77 and Mrs. Nash.
J. B. Pierce, '77 and Mrs. Pierce.
F. E. Idell, '77 and Mrs. Idell.
A. G. Brinckerhoff, '77 and Mrs. Brinckerhoff.
F. C. Jones, '78.
E. P. Thompson, '78.
R. S. Kursheedt, '80.
J. W. Lieb, Jr., '80 and Mrs. Lieb.
T. A. Elliott, '80 and Mrs. Elliott.
Durand Woodman, '80.
George M. Bond, '80.
Alex. C. Humphreys, '81 and Mrs. Humphreys.
J. W. Howell, '81.
Edw. Tatham, '81.
R. M. Dixon, '81 and Mrs. Dixon.
Harry Vanatta, '81.

Joseph Wetzler, '82 and Mrs. Wetzler.
Hosea Webster '82.
V. H. Rood, '82.
Pierce Butler, '82.
Fred. C. Fraentzel, '83.
H. A. Hickok, '83.
Jas. E. Sague, '83.
M. McNaughton, '83.
W. L. Lyall, '84.
W. S. Tuttle, '84.
D. H. Maury, Jr., '84.
H. F. Mitchell, '84.
E. P. Renwick, '84.
F. W. Foster, '84.
E. H. Foster, '84.
A. J. Wurts, '84.
K. Torrance, '84.
B. H. Coffey, '85.
A. W. Burchard, '85.
C. E. Machold, '85.
Edw. Burhorn, '85, and Mrs. Burhorn.
J. M. Rusby, '85.
O. F. Pfordte, 86.
C. J. Field, '86.
Wm. R. King, '86.
Wm. W. Randolph, '86.
E. T. Birdsall, '86.
J. H. Cuntz, '87.
J. L. Cox, '87.
A. H. Schlesinger, '87.
J. D. Flack, '87, and Mrs. Flack.
W. E. Schoenborn, '87.
W. E. Parsons, '87.
M. C. Beard, '87.
Jos. A. McElroy, '87.
C. A. Lozano, '87.
L. W. Serrell, '87, and Mrs. Serrell.
W. S. Dix, '87.
H. A. Wagner, '87.
Geo. Dinkel, '88, and Friends.
J. V. L. Pierson, '88.
Edw. Ducommun, '88.
A. S. Miller, '88.
A. A. Fuller, '88.
Paul Doty, '88.
H. E. Reeve, '88.
E. L. McBurney, '89.
W. W. Jackson, '89.
H. L. Ebsen, '89.
F. J. Gubelman, '89.
J. Eastwood, '89.
Chas. F. Wreaks, '89.
W. J. Hamilton, '89.
J. H. Stewart.
H. M. Brinckerhoff, '90.
E. H. Peabody, '90.
Shirk Boyer, '90.
Carl Graf, '90.
A. H. Hall, '90.
W. N. Carlton, '90.
H. Torrance, Jr., '90.
J. S. De Hart, '90.
E. H. Whitlock, '90.
C. J. Everett, Jr., '90.
L. D. Wildman, '90.
A. R. Whitney, Jr., '90.
E. S. Lorsch, '91.
J. A. Dixon, '91.
J. A. Davis, '91.
Paul Spencer, '91.
Alex. Dow, '91.
W. O. Ludlow, '92.
H. C. Meyer, Jr., '92.
F. W. Gardiner, '92.
A. R. Hake, '92.
Adolf Hupfel, '93.
C. T. Rittenhouse, '93.
J. A. Goldsmith, '93.
B. B. Bristol, '93.
A. E. Bruen, '93.
Geo. L. Wall, '93.
B. G. Braine, '93.
H. A. Griswold, '93.
J. V. Macdonald, '93.
W. K. Hunter, '93.
F. D. Crane,
L. Rupecht, '94.
C. C. Hartpence, '94.
Jos. G. Cottier, '94.
J. B. Klumpp, '94, and Mrs. Klumpp.

W. A. Jones, '94.
M. W. Kellogg, '94.
A. R. Lawton, '94.
H. L. Fridenberg, '94.
Percy Allan, '95.
F. W. Walker, '95.
F. K. Vreeland, '95.
B. H. Jackson, '95.
F. N. Taff, '95.
G. E. Bruen, '95.
J. B. Hamilton, '95.
W. H. Corbett, '95.
A. Lenssen, Jr., '95.
J. L. Christy, '96.
W. J. A. Boucher, '96.
B. C. Clark, '96,
W. H. Dickerson, '96.
W. J. Rusling, '96.
C. J. Woolson, '96.
Geo. Hewitt, '96.
H. T. Bernhard, '96.
C. F. Collyer, '96.
E. E. Burnet, '96.
H. C. Messimer, '96.
Wm. H. MacGregor, '96.

'97.

C. R. Christy, Jr.,
Jacob Cromwell,
Wm. Darbee,
F. D. Dates,
Warren Davey,
Wm. F. Doughty,
Louis A. Elleau,
Gordon L. Hutchins,
Walter Kidde,
E. R. Knapp,
Frank A. Koch,
Percy Litchfield,
Arthur B. Miller,
C. S. Mott,
Fredk. Ophüls,
A. M. Orr, Jr.,
Edw. Steinbrügge,
Wm. I. Thomson,
Henry D. Tieman,
A. E. Weichert,
Harry S. Morton,
W. S. Handforth,
E. J. Munby,

'98.

Robert Boettger,
F. D. Kennedy,
R. Ode,
R. deB. Prince,
J. A. Schmitt,

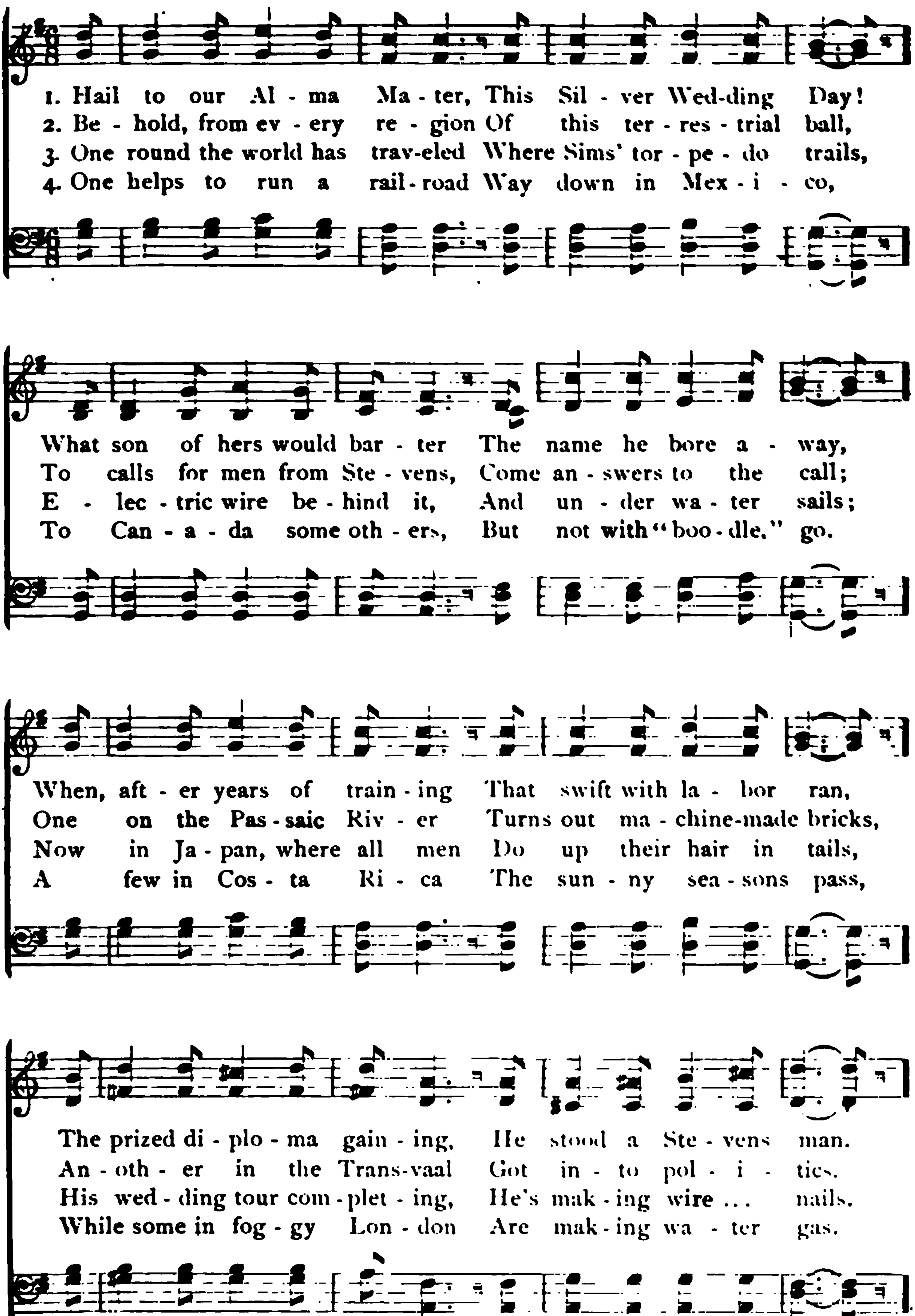
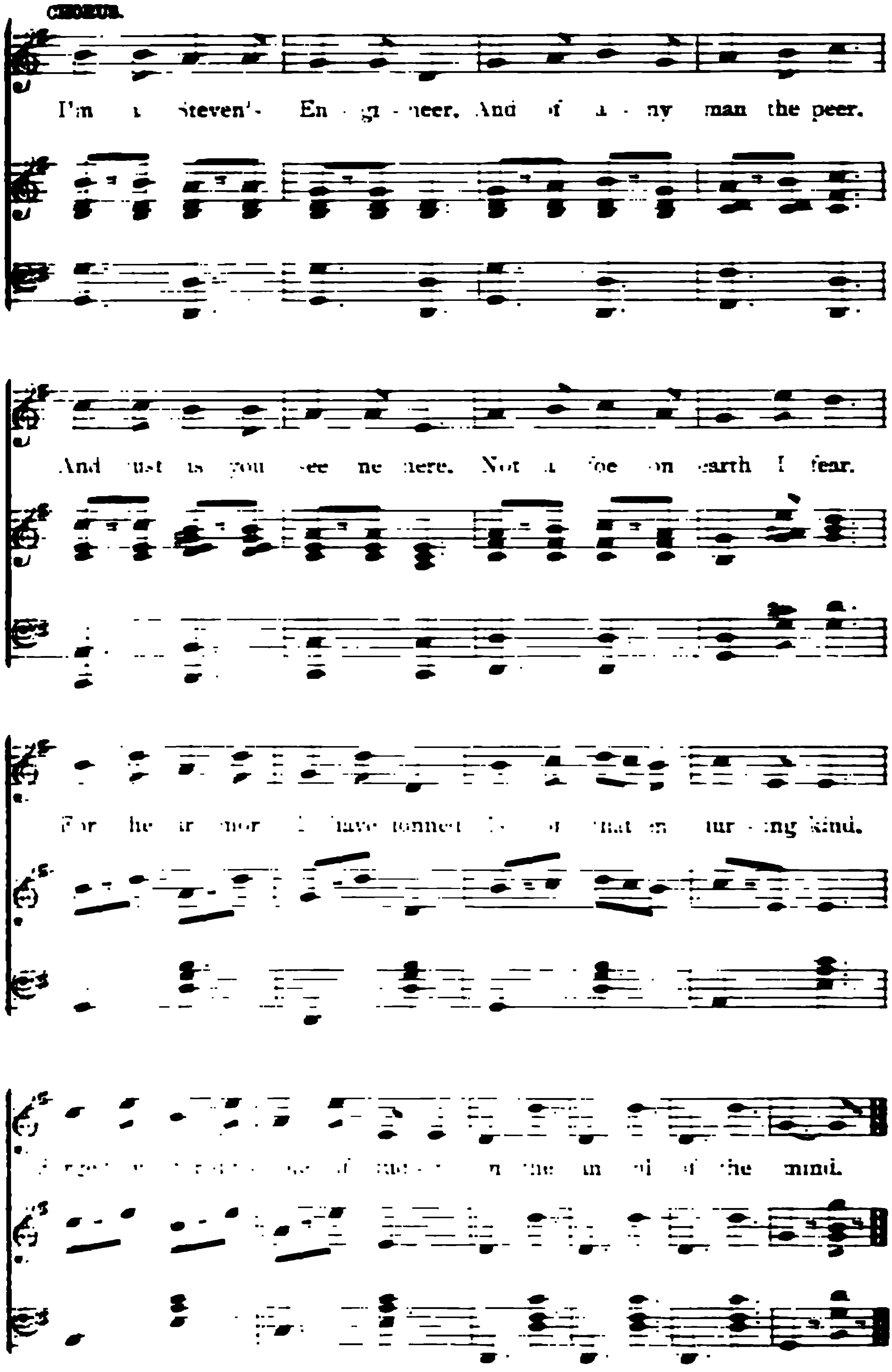
'99.

Geo. H. Beck,
H. M. Berg,
L. de L. Berg,
Geo. C. Cole,
Henry W. Crowell,
R. J. Decker,
J. S. Henry,
Harold Humphreys,
H. A. Kornemann, Jr.,
Geo. W. Martin,
A. G. Sidman,
J. R. Westerfield,

'00

L. A. Phillips,
F. D. Voorhees,

STEVENS MEN.

Words by HENRY MORTON. Music by FRANK L. SEVENOAK.

STEVENS MEN.—*Concluded.*

STEVENS MEN—1871-1876.

DEDICATED TO THE ALUMNI ASSOCIATION, ON THE CELEBRATION OF THE 25TH ANNIVERSARY OF THE FOUNDING OF STEVENS INSTITUTE OF TECHNOLOGY.

Hail to our Alma Mater,
  This Silver Wedding Day!
What son of hers would barter
  The name he bore away,
When, after years of training
  That swift with labor ran,
The prized diploma gaining,
  He stood a Stevens man.

CHORUS:
I'm a Stevens' Engineer,
And of any man the peer,
And just as you see me here,
Not a foe on earth I fear.
For the armor I have donned
Is of that enduring kind,
Forged by sturdy strokes of study
On the anvil of the mind.

Behold, from every region
  Of this terrestrial ball,
To calls for men from Stevens,
  Come answers to the call;
One on the Passaic River
  Turns out machine-made bricks,
Another in the Transvaal
  Got into politics.

CHORUS.

One round the world has traveled
  Where Sims' torpedo trails,
Electric wire behind it,
  And under water sails;
Now in Japan, where all men
  Do up their hair in tails,
His wedding tour completing,
  He's making wire nails.

CHORUS.

One helps to run a railroad
  Way down in Mexico,
To Canada some others,
  But not with "boodle" go.
A few in Costa Rica
  The sunny seasons pass,
While some in foggy London
  Are making water gas.

CHORUS.

Amid the snows of Russia
  One M. E. cast his lot,
While some who went to Cuba
  Find it of late too hot.
The Argentine Republic
  For one is doing well,
While one makes rapid transit
  In the land of William Tell.

CHORUS.

But each one thus to locate
  Would sure demand from me,
Being unprepared for "entrance," *
  Too much geography;
I'll only say in passing,
  That if I come to know
A place which wants a graduate,
  One there will straightway go.

* The entrance examinations which are currently reported to be quite beyond the attainments of the Faculty or Alumni.

Again there is no question
  Which town you choose to name
But graduates of [illegible]
  Are turning out the same
Thus should you ask for flour
  For bread or cakes or buns
[illegible] in Indiana
  Is grinding it by tons

Would you have lots of sugar
  To sweeten everything?
[illegible] went to Brooklyn
  Will daily carloads bring
Do you want food to carry
  Through desert regions far?
[illegible] will promptly ship it
  In tin can or glass jar

If streets are wet and muddy
  And rubbers meet your needs
Frank Jones can furnish shoes for
  Armies of centipedes
Is your head growing larger
  Demanding a new hat?
To Merritt go at Danbury
  He's just the man for that

Would you erect a palace
  [illegible]
[illegible] with plans and contracts
  [illegible]
Should you [illegible] gas works
  In this [illegible] land
A. H. [illegible]
  [illegible]

[illegible]

Do trolley rails attract you?
  Get them from C. J. Field;
Should lightning interrupt them,
  A. Wurts will make it yield.
Should you choose light electric,
  By a gas engine run,
To Nash convey the order,
  And straight the job is done.

But should you choose steam engine
  To drive the dynamo
To Zimmerman or Van Vleck,
  Or some one else you go.
For there's at least a dozen
  Who'll do the job all right,
So many have gone into
  Electric power and Light.

If temperatures you'd measure
  Where rock as lava flows,
Or where in solar region
  The white-hot-iron snows,
Or where too warm receptions
  Do visitors deter,
Ask Uehling to supply you
  With his pyrometer.

Would you engage in gauging
  The electricity
Which is not stored in barrels
  Like lightning of Jersey?
To Bristol go, who'll gauge it
  With meters that outshine,
In their smooth-running measures
  These halting lines of mine.

But if we tried to mention
  One half the things we might,
Made by our own Alumni,
  We'd not get through to-night;
So we will say in closing
  That if there's anything
Not made by our Alumni
  It's not worth mentioning.

EXHIBITION IN PHYSICAL LABORATORY. LOOKING EAST.

EXHIBITION OF WORK OF THE FACULTY AND ALUMNI.

A very interesting feature of the celebration of the 25th anniversary was the exhibition, held Friday, February 19th, in the Institute building, of machinery, apparatus, photographs, etc., which represented the work of members of the faculty and of many of the alumni.

The exhibits, numbering nearly 100 installations, consisted of machines and apparatus designed or invented by the exhibitors, and, where the exhibits consisted of photographs, they illustrated extensive engineering works planned by and erected under the supervision of graduates of the Institute.

Examples of the literary activity of the alumni were present in the form of technical works, numerous papers which had been

presented to engineering and other societies, and of contributions to technical journals. The exhibits were distributed in the physical and electrical laboratories, in the library, machine shop, and dynamo room, and were of an exceedingly varied character. They represented labor in almost every branch of engineering science, and served the purpose of giving, in a striking manner, a comprehensive view of the lines of work in which the graduates are engaged, and emphasized the success achieved by them.

During the hours from [illegible] A.M. to [illegible] P.M. the building was crowded with visitors to whom the exhibition offered much of interest, especially where machines were in operation and particular features were explained by the graduates or their representatives in charge.

As varied in character as the exhibits were, they did not by any means indicate all the kinds of engineering and scientific work in which the Stevens graduate is employed. Thus the work of graduates who occupy positions of superintendent of motive power or of master mechanic of railroads, or superintendent of manufacturing establishments, etc., could not be represented, although their work is equal in importance to any that was exhibited.

In order to give the public additional opportunity to see the exhibits and to satisfy a very general request it was decided to continue the exhibition on Saturday, February 20th, and Monday, February 22d.

Upon these days, also, the attendance was large, while but few of the exhibits were in operation. In the following enumeration of the exhibits brief descriptions of some of them are added to further indicate the extent and character of the exhibition.

W. S. ACKERMAN, M. E., '91, exhibited a water colored sketch of a section of a white-lead factory which he designed and erected for the National Lead Co. in Philadelphia, in 1896; also numerous photographs showing details of engine room, white-lead machinery, etc., which were installed in the above factory. Particular mention should be made of a photograph of an under-runner mill of massive construction for grinding carbonate of lead in water.

Mr. Ackerman has just gone in business for himself and will make the designing of factories for the manufacture of white-lead, colors and linseed oil his specialty.

J. S. ALDEN, M. E., '84, exhibited pamphlets on "Theory of Matter."

OSCAR ANTZ, M. E., '78, presented Drawings of a Compressed Air Snow Flanger.

C. G. ATWATER, M. E., '91, exhibited Photographs of Coke Ovens.

B. C. BALL, '95, exhibited a Tachometer, an optical instrument for observing the exact amount and the rate of variation from a constant speed of a revolving object.

Its accuracy depends upon the fact that a steel rod vibrates isochronously, no matter what the amplitude, within reasonable limits, may be. A steel rod is kept vibrating by means of an electro-magnet. This rod carries a screen which has a slit cut through it and this slit, when the bar is at rest, is exactly opposite a corresponding slit in a stationary screen, which is used as an eye-screen.

When the bar vibrates the slit in the eye-screen is seen to open and close at perfectly regular intervals of time.

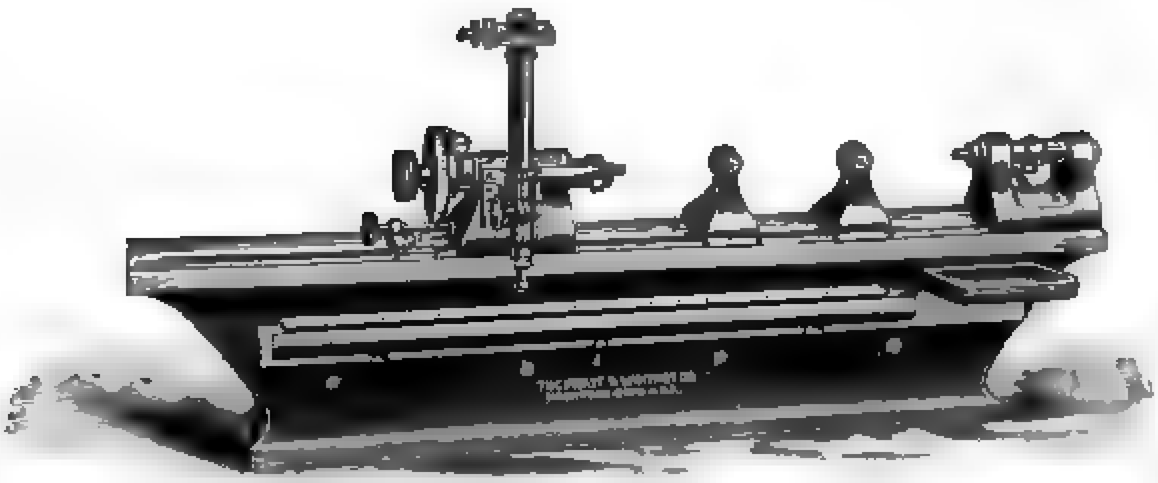
If some revolving object, as the fly-wheel of an engine, is in the field of view through the screen, and if its number of revolutions per minute just equals the number of semi-vibrations of the bar per minute, then it will appear to stand still.

If the revolutions and the vibrations do not coincide, they can be made to do so by moving the rider which the bar carries, thus changing the rate of vibration. If the adjustment is made so that the wheel appears to stand still the revolutions and vibrations coincide, and if the revolutions per minute then change in the least degree the wheel will appear to revolve forward or backward, as the case may be, and this apparent motion is the exact amount of the gain or loss.

This exhibit also included a throttling governor, which was designed to use the accelerating forces, due to a change of speed, to assist centrifugal force to affect the governing motion. Especial attention was given to the elimination of friction.

WM. O. BARNES, M.E., '84, exhibited a photograph of a steel type engraving machine which he invented and designed.

GEO. M. BOND, M.E., '80, exhibited a photo-print of a Standard Measuring Machine. This machine combines the features of an "instrument of precision" for measuring linear dimensions by means of a microscope and a finely graduated reference bar and also the application of the micrometer index screw with a most delicate attachment for determining [illegible]re of contact, both at zero and for the gauge measured.



BOND STANDARD MEASURING MACHINE.

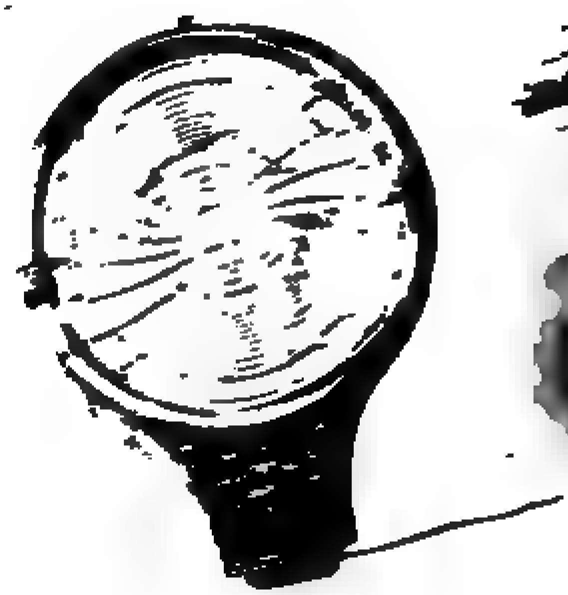
This machine is specially adapted to meet the requirements for laboratory and tool-room service.

B. G. BRAINE, M.E., '93, exhibited photographs of the Glasgow Harbor Tunnel Elevators, located at each end of the tunnel under the Clyde at Glasgow, Scotland, and used for raising and lowering vehicles to the tunnel; another part of the exhibit consisted of photographs, representing track construction, machinery room, etc., of the Lake George (N. Y.) Incline Railway and also the dynamo room and outside wiring of an electric-light plant, located at the same place. With the first of these engineering works Mr. Braine was connected as draughtsman and with the latter as assistant engineer.

H. M. BRINCKERHOFF, M.E., '90, exhibited a framed set of twelve photographs, being views on the Intramural Railway at the World's Fair, and on the Metropolitan West Side Elevated Railroad at Chicago.

Mr. Brinckerhoff was assistant engineer and joint patentee with C. H. Macloskie of the Third Rail System, here used for the first time, and the apparatus connected with it. The same system is in use on the Metropolitan Road and views show the Roll Lift Bridge, power station, cars, etc., all of which are operated electrically, the apparatus having been installed under his direction and supervision as electrical engineer of the railroad company.

Prof. W. H. BRISTOL, M.E., '84, in conjunction with B. B.



The construction and operation of the instrument are as follows: The bulb, which is to be placed at the point where the temperature is to be measured, is partly filled with alcohol, the remaining air is then exhausted from the bulb, the capillary connecting tube and the helical pressure gauge tube, and finally the entire system is hermetically sealed. If heat is then applied to the bulb the vapor of the alcohol condenses and completely fills the helical recorder tube and the capillary tube leading to it. The pressure due the temperature of the oven, pipe or closed space is then transmitted to the recording gauge, the scale of which has been graduated to read in degrees by means of a standard thermometer.

No compensation or correction is required for changes of temperature in the room where the recorder is located, as the recorder gauge tube and the capillary connecting tube are completely filled with the condensed alcohol, and pressures transmitted to the recorder depend entirely upon the pressures due the temperatures at the bulb.

Electrical recorders were illustrated by a set of three instruments, placed in an incandescent lamp circuit; the first recorded the voltage, the second the amperes and the third the watts. By varying the number of lamps in the circuit, the operation of the combined set of recorders could be readily observed, affording a simple and effective method of illustrating the relation existing between voltage, amperes and watts of an electric current.

Mr. Carl Trautvetter, '90, who is electrician for The Bristol Co., personally prepared the electrical recorders for the exhibition. To meet the wide range of commercial requirements, over one hundred different varieties of these recorders have been designed. Several thousand instruments have been sold and are in daily use, orders having been received from almost every civilized part of the world.

In addition to the line of recorders a complete set of patent steel belt lacing was also exhibited.

Morgan Brooks, M. E., '83 exhibited drawings of an Automatic Telephone System for Villages which he patented Nov. 3, 1896.

This system is designed to meet the demand for a simple and reliable automatic telephone service in places where the expense of an operator is prohibitory. The wires composing the system do not meet at any central point, but pass in series through all subscribers' instruments, and return into themselves, forming an endless circuit. The peculiar feature of the system lies in connecting the bells each with two of the wires by a method which permits a selective signal to be sent from any station, calling only the party wanted. A number of wires, N, in a given system allows N (N-1) different call-bell connections; hence 40 stations require but 7 wires. For operating the call bells from a distance no apparatus is required more complicated than the ordinary telegraphic relay, which is noted for certainty of action. The relay connections do not make any cross between the wires, each of which is always an independent metallic circuit. These metallic circuits are used for conversation, and there may be as many simultaneous conversations without interference as wires in the system. Each subscriber has a telephone set, and a small switchboard giving him command of the entire system. For quickness of action this system is noteworthy, as it takes but three seconds to call any subscriber. A "busy" test prevents unnecessary intrusion. This system has advanced beyond the experimental stage, a practical trial at Northfield, Minn. having substantiated the claims made for it.

Edwin Burhorn, M. E., '88. This exhibit consisted of:

1. Photographs showing the complete power plant of the Dodge Cold Storage Co. system of the Erie Railroad at East Buffalo, N. Y., and principally the plant for furnishing power to the Dodge system as designed and erected by Messrs. Burhorn and Granger and erected under the supervision of C. E. Machold, '85. The steam plant consists of a boiler house containing two 150 H. P. boilers and three engine houses. The steam is carried from the boilers to the engine houses in a straight run of pipe carried on rollers mounted on specially designed tracks and supported on iron frames about 8 feet above the ground. At each engine house is placed a combined separator and expansion joint. The engines are of the plain slide valve type, 60 H. P. each, running 200 revolutions per minute.

2. Photographs of the Woodbury Engine showing a recent type with the improvements in lubricating and crank guard, designed by Burhorn & Granger, and installed in various buildings in the vicinity of New York City.

3. Blue prints of proposed boiler house at Ridgewood for the City of Brooklyn.

The steam boilers and generating plant were designed under the personal supervision of Mr. Burhorn.

WM. S. CHESTER, M. E., '86. This exhibit consisted of photographs and sketches showing the development of the use of the electric motor for organ blowing. The first electric motor applied for this purpose was installed in St. Paul's Chapel, New York City, and gave entire satisfaction. Its initial trial was witnessed by many who were interested in this specialty. Due notice was also taken of the first motor installed in Brooklyn.

From this beginning a department has been made in the C. & C. Electric Company and they now have over one hundred motors in the vicinity of New York that are doing their work satisfactorily for this purpose.

Sketches of several plants showing the method of arrangement and connection together with numerous testimonials were also exhibited.

BARTON H. COFFEY, M. E., '85, presented photographs of a Dredging Plant which was erected and maintained under his supervision. The pumps were specially built according to his designs.

CHAS. RUSSELL COLLINS, M. E., '86, is the inventor of an oil-spraying device, for use in the production of carburetted water-gas, for injecting oil or other liquid hydrocarbons into the water-gas.

The principal objects of the invention are to obviate waste of the liquid hydrocarbon and to hasten and facilitate and finally attain a more perfect carburation of the water-gas than has been heretofore possible; and that this be accomplished economically and in a comparatively inexpensive manner.

It is also claimed that the arrangement of the parts is such that they can be readily detached and assembled and that means

are provided for adjusting the operative parts in order to compensate for their expansion, contraction and wear.

Mr. Collins exhibited a copy of his patent and a sectional model of the device.

A. A. Fuller, M. E., '88, F. N. Connet, M. E., '89, and W. W. Jackson, M. E., '89, who are connected with the Builders' Iron Foundry, Providence, R. I., as Supt., Chief Draughtsman, and Draughtsman, respectively, exhibited 40 photographs illustrating the work of this Company.

Also a 14″ Polisher on Column which differs from the average machine of its class in having a spindle of unusual length and stiffness, provided with special ring and scraper devices to secure copious lubrication. The frames are extended so that pieces of awkward shape can be easily polished.

The exhibit also included a 10″ × 18″ countershaft and a 2″ universal belt shifter—designed and patented by Mr. Connet—which shift the belt on and off the loose pulley by successive pulls of a single rope.

The universal belt shifter was presented to the Institute by Mr. Connet.

In addition to the above the exhibit included a Venturi meter, for measuring large volumes of water, which consists merely of a contracted tube of certain proportions, and whose operation depends solely on the relation established in it between velocities and pressures. A recording instrument also accompanied the meter.

Venturi meters which measure the entire water supply of several cities are in successful operation.

John S. Cooke, M. E., '79, and Fred. W. Cooke, M. E., '82, the former President and Gen'l Manager, and the latter Vice-President of the Cooke Locomotive and Machine Co., of Paterson, N. J., exhibited photographs of locomotives built by their Company.

Hermann F. Cuntz, M. E., '94, exhibited a catalogue of the Pope Tube Company of Hartford, Conn., containing information, in tabulated form, giving the necessary gauges of tubing in decimals of an inch for equivalent transverse strength in the different

sizes. To make this table universal and applicable as well to all intermediate sizes the curves of equivalent transverse strength were plotted. The original of these curves was drawn by Mr. Cuntz on a large scale and reduced for publication.

J. H. CUNTZ, C. E., M. E., '87, exhibited some of his literary work in the form of pamphlets on "Money."

One of these pamphlets, entitled "Our Money, As It Is," was published by the Sound Currency Committee of the Reform Club of New York; the title of the other was "Plain Words About Silver Money."

O. G. DALE, M. E., '93, had on exhibition a small steam engine which he designed and built when he was a student. The engine was in operation during the exhibition.

PROFS. DENTON AND JACOBUS exhibited the apparatus used by them for instruction purposes in the Department of Experimental Mechanics.

Profs. Denton and Webb exhibited jointly a friction brake specially designed for testing steam turbines. This brake has been used in testing a steam turbine running at a speed of 20,000 revolutions per minute and was found to be perfectly reliable in its action at this high velocity.

The brake consists of a disc which was coupled to the turbine shaft and enclosed in a stationary cylinder filled with water.

The cylinder was suspended by means of a wire which was subjected to a torsional strain equal to the friction between the revolving disc and the water and also that due to a speed counter mounted on the cylinder. The wire served as a torsional spring by which the work absorbed by the brake could be measured.

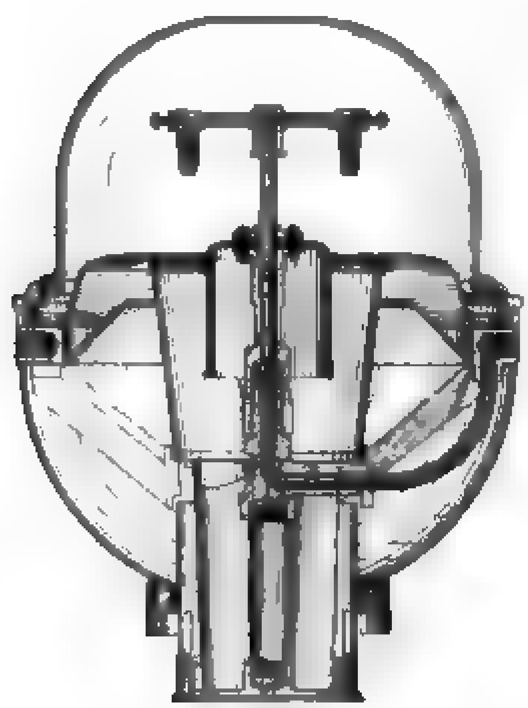
With a disc $4\frac{3}{16}''$ in diameter revolving at 20,000 turns per minute 16 horse-power was absorbed with perfect steadiness of action for an indefinite period.

A number of discs may be used with a clearance of $\frac{1}{16}''$ between their faces. A photograph was exhibited of a brake constructed on this principle, used in tests of a Curtis Steam Turbine which was capable of absorbing 200 horse-power at a velocity of 3,000 revolutions per minute.

R. M. DIXON, M. E., '81, engineer of The Safety Car Heat-

ing and Lighting Co., New York City, who has associated with him as assistant engineers, J. A. DIXON, '91, O. C. WHITNEY, '92, J. V. MACDONALD, '93, PERCY ALLAN, '95, and RUDOLPH BRUCKNER, '96, exhibited several lamps for lighting with Pintsch Gas System and model showing car equipment for heating with hot water. (See view of Exhibition in Phys. Lab. looking East.)

The accompanying illustration shows in section the construction of the lamp used in the Pintsch system of car lighting. It is claimed to be absolutely shadowless, radiating light upward to the ceiling and horizontally to the sides of the cars, while the maximum amount of radiation is below the horizontal, giving a very useful effect for reading purposes. It also combines great steadiness of flames in even severe drafts with maximum efficiency in consumption of gas secured by arrangements for heating the incoming air, by the heat of the outgoing products of combustion.



The lamp is usually suspended from the car ceiling by four arms, one of which forms the gas supply pipe and is connected at the tapping shown at the left of the illustration, from which the gas is conducted by the passage, shown in the illustration, to the place of combustion, which usually is of individual flames from two to six in number, or in some cases burners of the Argand type are used. The main flame or body of the lamp is a solid ring having four tappings, two of which are shown, for connecting the hanging arms. To the lower side of this ring is hinged another ring, carrying the glass bowl, which protects the flames from drafts. Above the bowl is an iron ring-shaped reflector, enamelled white on its under side, and near its outer circumference having holes for the admission of air to the interior of the globe. Another reflector, cup shaped, is also shown, and between these two reflectors is formed an annular space, which is the beginning of a flue for the outgoing products of combustion.

Resting on the inner edge of the ring-shaped reflector is a mica chimney forming a portion of the flue, and at the upper end of the mica chimney the flue is divided into four cylindrical iron flues. These four flues are surrounded by a cylinder having a flange which rests on the glass shade, the latter resting on the ring of the lamp. In order to relieve the weight of the upper or divided portion of the flue from the mica chimney, a spider-shaped casting carries the weight of this flue to the main frame or body casting of the lamp. There is a diaphragm fastened to the upper side of the body ring, which extends conically towards the mica chimney, but does not quite touch it. Near the upper end of the cylinder surrounding the four cylindrical flues are apertures for the admission of air. The lamp being lighted, the flues are heated, forming a draft which draws fresh air for combustion in through the orifices in the cylinder surrounding the flues. The air passes down around the four cylindrical flues, and thence along the mica chimney around the inner edge of the diaphragm between the diaphragm and ring reflector to the apertures or orifices leading into the space between the ring reflector and the bowl where the gas is burned. The whole course of the

The works were planned, the specifications prepared and the construction was supervised under the immediate direction of Mr. Doty.

E. H. Foster, M. E., '84, exhibited a photograph of a pumping engine which is one of the most recent examples of a high duty engine built by Henry R. Worthington.

This engine pumps 8,000,000 gallons of water at 100 ft. head and gave a duty test of 138,000,000 foot pounds for 100 lbs. of coal. The notable feature of this type of engine is the application of a "high duty attachment" consisting of a compensating device to maintain a uniform effort on the pump-rod throughout the stroke while working steam at high grades of expansion and without the use of a fly-wheel and crank motion and its accompanying disadvantages to a pumping engine.

A pair of oscillating cylinders fitted with plungers of equal diameter are carried in a frame and attached to each rod in such a manner that they will be forced in during the first half of the stroke, thereby storing up energy when the pressure in the steam cylinders is high and allowed to react during the latter half of the stroke, thus giving out energy to the piston rod when the steam has expanded to a low pressure. These compensating cylinders can also be made to serve as pump governors.

Mr. Foster entered the Worthington shops in 1884, when the above described feature was first introduced, and has been engaged in the manufacture, design and erection of these machines, having visited all parts of this country in their interest, and been in charge of an installation at the Paris Exposition in 1889.

Prof. F. D. Furman, M. E., '93, exhibited a tabulated review of standard draughting room methods.

The information given in tabulated form was obtained for the Department of Drawing by personal visits made by Mr. Furman to a number of representative manufacturing establishments of the country.

Professors Wm. E. Geyer and A. F. Ganz, Exhibit of the Electrical Department.

The machinery and appliances of the electrical department

were, so far as was practicable, shown in operation during the exhibition. A number of the regular laboratory exercises were also shown, accompanied by their respective schemes, thus showing the scope of the work and the methods of instruction of this department.

The following are a number of special experiments which were also shown:

A coil of wire was supplied with an alternating current; a second similar coil had its terminals connected to an incandescent lamp. Whenever this second coil was brought near the first coil the lamp would light up due to the current induced in the second coil. The effect could be greatly increased by placing an iron core inside of the coils, owing to the increased induction. The result is striking as the second coil with its lamp is not connected to any external circuit.

The effect of inductance and capacity in parallel was well illustrated by the following experiment:

A current, after passing through one lamp, divides into two branches. In one branch is placed a lamp and a condenser, and in the other branch a lamp and an inductance. The two branch currents then reunite and return to the source. The entire current supplied passes through the lamp in the main circuit, yet this lamp is only heated to a dull red, while the two lamps in the branch circuits are heated to white incandescence. The lamps are ordinary [illegible] volt lamps and may be shown to be alike by interchanging them. The result seems paradoxical, for it looks as if energy was created. The fact is that the energy is supplied in the form of a high pressure and small current, and this energy is transformed by the combined action of the inductance and capacity.

Another experiment was the following: A solenoid, having a lamp in its circuit, was connected to a special switch by means of which it could be connected to any one of three circuits. With the switch in the first position the lamp was lit to full brightness; upon thrusting an iron core into the solenoid the lamp was extinguished. In the second position the lamp was heated to a dull red; when the iron core was inserted the lamp immediately lit up to full brightness. In the third position of the switch the lamp,

lit to full brightness, remained unchanged upon introduction of the iron core.

The explanation of this is quite simple. In the first position we have an alternating current, and the lamp is extinguished because the iron core greatly increases the inductance and thus chokes off the current. In the second position a condenser is placed in circuit with the alternating current and only a small current can pass; the introduction of the iron core, however, increases the inductance so as to neutralize the capacity of the condenser. In the third position a direct current is used when inductance does not come in.

The lecture model of a polyphase induction motor, designed by Prof. Ganz and described in the July, 1896, number of the INDICATOR, was shown in operation on a three phase circuit. Various combinations of lamp circuits for three phase currents were also shown.

It may be worth mentioning here that the current for the entire lighting during the exhibition was supplied by the dynamo which was directly connected to the Nash gas engine.

GUS. C. HENNING, M. E., 76, exhibited the following instruments for testing materials:

1. Double Electric-Contact Micrometer.
2. Extensometer for Long Members.
3. Mirror Apparatus.
4. Wire Pocket Recorder.
5. Universal Pocket Recorder.

The first two of these instruments are fully described in Vol. XVI. Trans., A. S. M. E., p. 479. The Mirror Apparatus is described and illustrated in *American Machinist* of Feb. 11, 1897.

The double electric-contact micrometer is claimed to be truly symmetrical in its disposition about the test piece; it can be attached to all sizes and shapes of test pieces whose dimensions do not exceed 2¼" square, with equal accuracy and facility; and automatically measures off the gauge length accurately.

The essential elements of the mirror apparatus are a pair of rollers, each carrying a mirror, reflecting scales set at a distance into a telescope set at any convenient point; a pair of springs at-

tached at one end to the test piece bear at the other against the rollers which again bear on the test piece. Thus if the test piece changes its length the rollers move and thus revolve the mirrors which thereby reflect different parts of the scales in direct proportion to twice the ratio between distance of scales from mirror to the diameter of rollers.

The clamping frame is so arranged that the points attaching the lower ends of springs follow the diminution of test piece under strain, thus always maintaining the instrument in its initial position with reference to the roller.

The Wire and the Universal Pocket Recorders are also ingenious appliances for testing purposes.

The former instrument is used to obtain autographic stress-strain diagrams of wire up to the instant of rupture, recording the elastic limit, yield point, maximum load, point of rupture, elongation within elastic limit and at instant of rupture.

The Universal Pocket Recorder differs from the foregoing in that it is designed to apply with equal readiness to all test pieces in ordinary use and that the attaching points are spring-cushioned.

Wm. Hewitt, M. E., '74, exhibited samples of wire rope of ordinary and special constructions. These ropes are the product of machines which were designed and patented by Mr. Hewitt.

The samples were enclosed in a border of small wire rope spliced endless and showing that such rope can be spliced without increasing its diameter and without loss of strength, as has been found in the splice.

H. A. Hickok, M. E., '83, exhibited a centro-linead, a device for drawing perspective views and by which an accurate representation may be made of the details of the form and principal lines of a body for the purpose of mechanical or architectual constructions.

The instrument is particularly useful in drawing the perspectives of systems of parallel lines whose vanishing points are at considerable distances and fall outside of the drawing board.

George Hill, '81, exhibited Drawings and Photographs of Buildings.

N. H. Hiller, M. E., '89, exhibited Gauge Cocks and Automatic Valves for Refrigerating Machinery.

John W. Howell's exhibit was designed to show the development of the incandescent lamp from 1880 to 1895. The specimen lamps exhibited illustrated three steps in the development of the globe. These globes were at first blown from glass tubes in the factory, then at glass works, and later they were made by blowing them in a mould in order to insure the same size and shape for all bulbs.

There was shown the carbon filaments which were at first made of paper, then of bamboo which was carbonized by baking to a high temperature, and the bamboo with a bright surface given it by dipping the filament in an asphalt solution before carbonizing it. Bamboo filaments heated to very high temperature in an atmosphere of gasolene vapor and the latest kind of filament, made by dissolving cotton in chloride of zinc and squirting it through a die into alcohol and afterwards treated by the hydro-carbon process were also exhibited.

Three forms of the carbon filament were shown, viz.: the loop, the spiral and the oval forms.

The development in the method of making the joints between the platinum wire and the filaments was shown by the following steps:

1. A mechanical screw clamp. 2. A joint made by depositing copper upon the end of the leading wire and the end of the filament. 3. A deposit of carbon upon the wire and filament. 4. A carbon cement joint which is put on in the form of a paste, and carbonized by heat.

Another part of this exhibit represented the lamp of the present day, and also the parts entering into it.

Alex C. Humphreys, M. E., '81 and Arthur G. Glasgow, M. E., '85, of the firm of Humphreys & Glasgow, exhibited a handsome set of photographs representing a few of the water gas plants that they have erected in America and in Europe.

The illustrations were well selected and showed careful attention to details and to everything that goes to make up a perfectly equipped water gas plant.

[illegible]

[illegible] finished and [illegible]

[illegible] compared with this [illegible] instruments which [illegible]

[illegible] Messrs. [illegible] develop and con- [illegible]

[illegible] which comprised the [illegible]

[illegible] pressures up to [illegible] pounds [illegible] used up to this limit, upon [illegible] hydraulic gauges.

2. An apparatus for exhibiting the distribution of moisture in a steam main. A 3-inch glass tube was mounted horizontally so that the action of the moisture could be seen through its sides. There was also a special device which allowed the action of moisture in entering a collecting nipple of a calorimeter to be apparent to the eye.

3. Apparatus for standardizing indicators and thermometers.

WM. A. JONES, M. E., '94, presented an illustration and description of a 15" slotting machine, designed by him for the Betts Machine Co., of Wilmington, Del. This machine was sent to a locomotive plant in Russia.

J. F. KELLY, B. S., '78, exhibited a 40 k. w. induction generator and electrical measuring instruments. A full description of this exhibit will be found in another part of this issue.

WM. KENT, M. E., '76. This exhibit included:

1. Transmission Dynamometer designed by Mr. Kent in 1876 and built in the Institute shops.

2. Torsion Balance—Druggists' Prescription Scale, designed in 1887.

3. Torsion Balance Pivot.

4. Truss for Torsion Balance, produced by Toggle Joint Press, designed for compressing it.

5. Photograph of Transverse Testing Machine for small bars.

6. Patent drawings and specifications for several inventions including Blast Furnace, Blowing Engine, Water Tube Steam Boiler, Welding Furnace, Machine for Making Tubes, Flanging Machine, Headers for Water-tube Boilers, Boiler Furnace and Grain Meters.

7. Sketches of proposed Testing Apparatus for Determining the Resistance of Metals to Repeated Shocks.

8. Sketches of Apparatus for determining the heating value of coals.

Also Kent's Mechanical Engineer's Pocket Book and volume of papers presented to engineering societies, and of articles prepared for the technical press.

Wm. R. King, M. E., '86, exhibited an electrical furnace designed by him for laboratory use. It consisted of a piece of carbon placed between carbon terminals, the carbon conductor being heated to a high temperature by the passage of a current of electricity through it.

Mr King illustrated the action of his furnace by making calcium carbide. For this purpose he placed in the carbon conductor, which was hollowed out, a mixture of lime and charcoal and in a very short time produced a small piece of the carbide.

Prof. Chas. F. Kroeh's exhibit consisted of the following text-books: The Pronunciation of French, the Pronunciation of German, The Pronunciation of Spanish, Descripciones Científicas, The French Verb, How to Think in French, How to Think in German, How to Think in Spanish. The last three are according to the author's Living Method, which aims at giving a practical command in speaking by enabling the learner to use his vocabulary like a native. The Link of 1895 contains a list of Prof. Kroeh's professional papers, translations, etc.

J. B. Ladd, M. E., '[illegible], exhibited Photographs of Blast Furnace and Steel Works.

Dr. Albert R. Leeds exhibited improved forms of apparatus which he had devised for the quantitative measurements of Micro-organisms and Bacteria in water. They were illustrated by an exhibit of the micro-organisms in the Croton water supply of New York, water from Pequannock supplied to Jersey City, and the water from Hackensack River supplied to Hoboken. He also exhibited a series of cultures showing the different forms of bacteria found in the surface waters and in the 300 shallow and deep wells constituting the water supplied to Brooklyn. Two plates showing these bacteria drawn under the camera lucida and magnified [illegible] diameters, and four plates of the micro-organisms magnified [illegible] diameters were also shown, being part of the forthcoming report to the City of Brooklyn on the tastes and odors affecting the water supply and the methods of effecting their prevention and cure. (See Exhibition in Phys. Lab. looking North.)

J. W. Lieb, Jr., M. E., '80. This exhibit consisted of four large photographs of electric lighting and electric railway con-

struction in the City of Milan, Italy, installed under the direction of Mr. J. W. Lieb, Jr., during his engagement from 1882–1893 as the Chief Engineer and Director of Stations of the Italian Edison Company.

Photo. No. 1. General view of the Edison Central Lighting Station in Milan, Italy.

The service in this station was inaugurated in 1883, and it was the pioneer station on the Continent for the general distribution of current for public and private lighting and electric power.

Photo. 2. A series of views along the route of the electric trolley road in the City of Milan, Italy.

The success of this road has been such that the Italian Edison Company has been awarded the franchise for the entire street railway service of Milan, the electric trolley displacing an excellent horse car system.

Photo. No. 3. Monumental Arc Lamp Post.

One of the features of the city arc lamp installation, combining on one post high tension lamp for every day use, and three low tension lamps for use on gala occasions.

Photo. No. 4. General view of the Cathedral Square, Milan, Italy.

Showing the equipment of the monumental square in front of the celebrated Milan Cathedral, with ornamental high tension arc lamp posts, all wires being underground, and utilization of part of the same poles for an electric trolley service.

A de la M. Lozier, M. E., '94, exhibited an Automatic Electric Sounding Machine. It consists of a hollow steel shell containing a Bristol pressure gauge connected by an orifice to the outside of the shell, and so arranged that when immersed the pointer of gauge varies the resistance of a rheostat. This variation (due to different pressures and corresponding to different depths) is indicated automatically on board-ship by means of a voltmeter, which is calibrated in fathoms. The cable fastened to the shell or sinker consists of three wires carefully insulated and is mounted on a reel, so that the sinker can be readily lowered into the water.

The uses of this apparatus are to provide the means of ascertaining the depth of water under a vessel without measuring the amount of line overboard or without lifting the sinker to do so. It can be kept overboard for an indefinite length of time, and if the vessel is going slowly enough to permit sinker to remain on the bottom, it will show a continuous indication of the depth of the channel through which the vessel is passing.

*WM. O. LUDLOW, M. E., '92. Of Ludlow & Valentine, Architects, 100 Broadway, New York City, exhibited a number of water color and pen and ink sketches, and rendered plans, which represented the work of the firm.

A building for the East Orange National Bank, now nearly completed, was shown by a perspective drawing and floor plans.

A mill for the Sterlingworth Railway Supply Co. was a subject of a water color perspective and blue print plans.

Residences for Mr. W. F. Moore, at Flatbush, and Mr. S. S. Johnson, at South Orange, were shown by pen and ink perspectives and plans.

EAST ORANGE NATIONAL BANK.

A country seat for Mr. J. M. Valentine, at Chappaqua, N. Y., was shown by photographs of the exterior and interior and a building for the Shakesperian Society, of Wellesley College, to be built in old English style, was represented by a water color drawing.

PROF. MAC CORD'S exhibit consisted of a set of models, ten in number, illustrating problems in descriptive geometry and mechanical movements, and the following text-books:

Kinematics or Mechanical Movements.

Mechanical Drawing, Progressive Exercises and Practical Hints.

Elements of Descriptive Geometry.

The models exhibited included five Olivier models, viz.:

1. Circular and Elliptic Hyperboloids.

2. Parabolic Hyperboloid and Limiting Plane.

3. Two Tangent Hyperboloids of Revolution with their Common Normal Parabolic Hyperboloid.

4. Two Intersecting Cones.

5. Model exhibiting the following surfaces, viz.:

a. Circular Cylinder.

b. Elliptic Cylinder, 1st Derivation.

c. Elliptic Cylinder, 2d Derivation.

d. Right Circular Conoid.

e. Elliptic Conoid.

f. Warped Surface—two Circular Directrices, with Plane Directer.

g. Warped Surface—two Circular Directrices, without Plane Directer.

h. Cylindroid, derived from 2d Elliptic Cylinder.

An illustrated description of this last model is given in this issue of the INDICATOR, the first four were described in the preceding number.

Besides the Olivier models there were two other models of special interest to students of descriptive geometry, viz.:

A Celluloid Model illustrating Formation and Development of Lower Nappe of the Developable Helicoid.

A wooden model exhibiting both nappes of the Developable Helicoid.

These two models were described and illustrated in the STEVENS INDICATOR, July 1896.

The *Mechanical Models* shown were:

Model illustrating the Oldham Coupling and the Elliptic Chuck. Description and Engraving.—INDICATOR, Oct. '91.

Differential Planetary Wheel Train-Circular.

Elliptic Planetary Wheel Train.

A mechanical paradox in which, while the driving shaft turns uniformly, the last wheel of the train revolves first in one direction and then in the other. It was illustrated and described in the *Scientific American Supplement*, No. 1[illegible]2.

These models were made under the supervision of Prof. MacCord who, moreover, partially constructed some, assembled others, invented the most of them, and designed the whole.

W. H. MACGREGOR, M. E., and R. T. KINGSFORD, M. E., '96, exhibited an apparatus for indicating a steam engine under rapidly and constantly varying load.

This was the outgrowth of the necessity for determining accurately the horse-power of an engine directly connected to a dynamo, the current from which was used to drive a motor for elevator service.

Two ordinary indicators were used as a basis. To each of these was added a plate, one to carry a roll of paper on a spindle, and the other at the crank end to carry two rubber rollers. By means of a pulley on one of these rollers and a countershaft belted to the engine shaft, the paper was drawn along by the indicator drums at a uniform speed which would be, of course, proportional to the speed of the engine.

The pencils of the indicators were kept pressed against the paper by springs, and these traced continuous curves, one for each end of the cylinder. To mark the end of each stroke steel points actuated by electro-magnets were used. These dotters punched minute holes in the paper at the instant the piston reached the end of its stroke, the circuit of the electro-magnets being broken by a break on the cross head.

By making the proper allowances these distorted cards could be measured like an ordinary card, and the horse-power of the

engine accurately determined for each stroke of the engine. In the first application of this apparatus the horse-power of the engine varied from 30 to minus 10 and back again to 30 H. P. in less than 5 seconds, the apparatus giving 300 cards from the head and the same number from the crank end.

DABNEY H. MAURY, JR., M. E., '84, exhibited a photograph and blue prints of a steel tower and tank, together with specifications for the water works system of which the tower and tank form a part. The system illustrated is that of the Peoria Water Co., Peoria, Ill., and was designed by Mr. Maury and erected under his supervision.

PROF. ALFRED M. MAYER exhibited a number of floating discs and rings, described in the October, 1896, number of the INDICATOR. He also showed how floating magnetic needles arrange themselves in regular geometrical figures under the influence of a magnet suspended over them. Of acoustic apparatus Dr. Mayer exhibited his topophone for determining the direction from which a sound is coming; also a sound mill consisting of four resonators mounted so as to revolve when placed near a vibrating tuning-fork.

PRESIDENT MORTON'S exhibit consisted of the following group of objects:

1. A collection of several hundred samples of single and double salts of Uranium (many of them made for the first time) upon which he had made the research as to the "Fluorescent and Absorption Spectra of the Uranium Salts," published during 1873 and 1874, together with colored drawings of such spectra and apparatus used in this investigation.

2. Specimens, drawings and apparatus illustrating another research as to the "Fluorerscent and Absorption Spectra of certain solid distillates of Petroleum.

3. Various apparatus used in optical projection or the exhibition by means of images on the screen of phenomena of sound, light and magnetism.

4. Paintings representing various lecture illustrations such as that of the luminous electric tubes shown above.

In addition to these there were hung on the walls a number

of original designs and lithographic impressions in color, made by Dr. Morton prior to his connection with the Institute in connection with his work on the translation of the hieroglyphic inscription on the Rosetta Stone and as title pages for other compositions of his own. These were rather decorations than exhibits, but we refer to them by way of completeness.

Various volumes were also exhibited containing articles on special subjects, such as the articles on "Electricity" and "Fluorescence" in Johnson's Encyclopedia," one on "Solving Electricity" in *Harper's Monthly*," on "Electricity in Lighting" in *Scribner*," and the like.

LEWIS H. NASH, M. E., '77, exhibited one of his 20 H. P. gas engines connected directly with a Riker 20 H. P. generator.

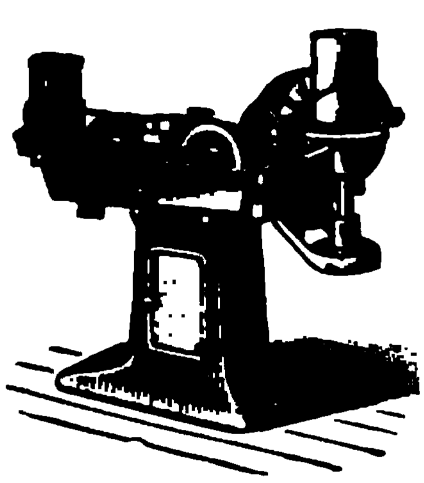
(See p. 227.) Also water meters of the several varieties now manufactured by the National Meter Co., of Brooklyn, N. Y., known by the names Crown, Gem, Empire, Nash and Improved Gem Meters.

Mr. Nash has taken out about sixty U. S. patents on water meters which he has assigned to the above company. The gas engine and dynamo included in Mr. Nash's exhibit have been added to the permanent outfit of the Department of Applied Electricity, the purchase money having been secured by subscriptions as announced in this issue under "Recent Gifts to the Institute." A description of the gas engine appeared in the April, 1896, INDICATOR.

W. P. PARSONS, M. E., '80, exhibited Photographs and Drawings of Cotton Compressors.

O. F. PFORDTE, M. E., '86, had on exhibition Samples of Concentrated Ores and Photographs of Mining Regions in Peru and Colorado.

WM. D. PIERSON, M. E., '94, exhibited a continuous wire drawing machine, shown in the accompanying cut, which was designed for drawing wire by a continuous method, and is known as the No. 1. Cone Wire Machine, built by the Waterbury Machine Co., Waterbury, Conn.



The machine consists essentially of a drawing roll, die holder, idle rolls around which the wire passes in going from one die to another, and the block on which the wire is finally wound. The drawing roll is built up in sections forming practically a cone. The shaft on which they are keyed carries the tight and loose pulleys for driving the machine, and runs in long babbitted bearings. The smallest section is nearest the bearing, and going outwards they increase in diameter by a constant quantity. This increase is to take up in part the elongation of the wire due to the reduction in size. The entire elongation is not thus compensated for, because in drawing fine wire, a certain amount of "slip" on the rolls is advantageous, and prevents a possibility of breaking, which might occur if the proportions were too exact. Each one

of the rolls is faced with a hardened tool steel ring to resist wear and insure a smooth surface for the wire to pass over.

The die holder is a hollow casting, carrying nine die boxes on receptacles for the dies. The idle rolls are merely grooved pulleys loose on a shaft, their speed being governed by the travel of the wire. These three parts overhang in the tank which forms the body of the machine, and contains the lubricant consisting generally of soap and water. It is filled to a depth sufficient to allow the rolls to be partly submerged, and in addition, a centrifugal pump beneath the machine keeps a constant circulation from the tank into the die holder, and thence into each die box, the supply being regulated by a valve, and the overflow falling back into the tank. Perfect lubrication is essential to prevent wear on the dies, and to keep the parts cool, and the stream being directed against the inner surface of the dies, all grit, etc., is washed away.

To reduce vibration, the block is driven by a belt from a vertical shaft, which is bevel geared from the driving shaft, and its speed is so calculated, that by putting a pulley of the same diameter on the block shaft as on block used, the circumferential speed of the block will be the same as that of the last roll on the cone. The bracket which carries this block is arranged to slide along a groove, allowing blocks of different diameters to be used, and permitting them to be run in either direction. A die box is placed between the last roll and the block to be used for finally sizing the wire, and as the lubricant in this box is behind the die, the wire is dry when it reaches the block, thus preventing rust. On the left hand side of the pedestal, an adjustable reel bracket is provided for carrying the coil of wire preparatory to drawing. The machine is driven by tight and loose pulleys, 18" diameter by 4" face, and by means of a convenient hand lever, the operator may start or stop it at will.

To string up the machine ready for drawing, one end of the wire is pointed by filing or other means, and is started through the first or largest die. This die is then placed on the hook shown on the left of the tank, and by means of pliers, a sufficient length can be drawn through by hand to go around the first roll one and one-half times, then back around the ide roll and up to

the die holder. The end is next put through the second die and another length drawn out, each die being placed in its die box as it is filled. This operation is repeated until the nine dies are in use, when the wire will be on the last roll. It is then put through the finishing or tenth die, and finally fastened to the block. It will be seen that the wire in passing from one die to another, goes through the lubricant, at the same time being kept cool during the passage through the die.

The speed of running this machine depends on the nature of the wire, etc., though about two hundred and fifty revolutions per minute can be taken as an average, for a six inch block. This gives about four hundred feet of wire per minute, so that when we compare the method of using one die at a time, and continuous drawing, the saving in time and labor is very apparent.

HENRY W. POST, M. E., '74, exhibited Plans of Steel Construction for Buildings.

HENRY S. PRENTISS, M. E., '84. Exhibit: Synchronized Clocks, manufactured by the Prentiss Clock Imp. Co., New York City, of which Mr. Prentiss is President. (See view of Exhibition in Phys. Lab., looking North, against further wall, about middle of picture.)

This exhibit consisted of one ninety-day mechanical self-winding calendar clock, fitted with contact and used as a master clock for controlling other clocks, a synchronized sixty-day calendar clock and also a sixty-day gallery clock without a calendar. There was also exhibited a time-switch for automatically turning off electric lights, this device being connected with the calendar of one of the clocks, so that when the calendar was set off the switch was also operated. The feature of the master clock consisted in the extra long run on one winding, so that this clock requires winding but four times a year, and during this time it automatically rewinds a small spring at frequent intervals, thus furnishing an excellent time-keeper, equal if not superior to an eight-day weight movement. The synchronizing devices shown are a novelty in their way, as instead of the old plan of setting the hands by forcing them together at the hour, in case they do not indicate correct time, the new method of synchronizing the

train of the clock is used. By this plan the sub-clocks are regulated to run correctly or very slightly fast, but never slow. At each hour the master clock holds up the sub-clocks if they have gained during the preceding hour, so that they all start together on the hour correct. The advantage of this system is that it may be applied to any size of clock, tower clocks and time stamps and time recorders, synchronizing equally well on the same line. The time switch exhibited is also a novelty, and it is worked by a separate current from the clock, which may be placed at any convenient point. The ordinary type of knife-switch is used, which is sufficiently removed from the operating device of the switch to satisfy all the requirements of electrical installation. The calendars exhibited are also unique in the fact that they show very large dates and one date at a time, arranged in very compact form in the case of the clock. The calendar part requires winding but once a year and does not need any re-setting or adjusting after once being started, provision being made for the inequality of the months and also for the odd day in leap year.

[illegible] exhibited one of his screw pumps in connection with a Hunt electric switch for automatically starting and stopping [illegible]

The pump was in operation during the exhibition.

[illegible] exhibited blue prints of the [illegible] and specifications for same, [illegible] immediate installation of [illegible] cross compound condensing [illegible] foundations for a 1300 H. [illegible] boilers.

[illegible] lighting of the Massillon. [illegible] when completed, about [illegible] municipal plant [illegible]

[illegible] electric light plants, [illegible] and plans for the [illegible]

[illegible] School of Technol-

ogy, of which Mr. Roberts is President, and Mr. Oscar Antz, M. E., '78, Associate Instructor.

H. R. RICE, M. E., '85, exhibited Photographs of Engines of the Rice & Sargent Co., Providence, R. I.

GEORGE J. ROBERTS, M. E., '84, showed a Model of a Water Gas Plant, with improvements as manufactured by the United Gas Improvement Co. of Philadelphia.

LOUIS RUPRECHT, M. E., '94, who is located at the smelting works of the National Lead Company, at Flatlands, L. I., exhibited specimens of various alloys of lead, tin, antimony, copper, zinc, bismuth, nickel, etc., such as Babbitt metals of all grades, linotype metal, stereotype metal, electrotype metal, bronzes, etc.

These alloys are prepared by processes with which Mr. Ruprecht has experimented and which he has helped to develop.

JAS. E. SAGUE, M. E., '83, Presented Photographs of Locomotives.

H. R. SMITH, M. E., '88, presented an Illustrated Description of an Electric Elevator.

ALFRED H. SCHLESINGER, M. E., '87, exhibited a hard rubber pump for handling corrosive liquids. In his design Mr. Schlesinger abandoned all former constructions of the rubber parts and has adapted the pump end so as to facilitate its manufacture and to make its moving parts readily accessible, and so that the cylinder, valve seat and valves can be renewed without discarding the valve chests and parts.

All constructive strains are borne by the iron frame and bolt, and by uncoupling the piston rod at crosshead and the tie rods to steam end the pump end can be removed from the main bed plate complete.

H. J. SCHUMACHER, M. E., '91, exhibited a folding kite, consisting of two aeroplanes arranged "fore and aft," each serviceable as separate kite and consisting of tridimensional truss frame, to which cloth or paper is so attached as to form an aeroplane having three fins projecting above and below aeroplane sur-

face. The two are connected by tridimensional truss framing, forming double kite, or kite proper. Flexible and detachable joints and adjustable tension members are so used as to enable compact folding and various adjustment for rectification and deflection of flight and observation of effect of various forms and relative positions of aeroplanes.

In extreme performances this kite has been raised from hand by manipulation of string through inconsiderable surface-current to steady flight in upper current, and has with 5 sq. ft. aeroplane area recorded 6 lbs. pull.

It is well adapted to manipulation in irregular wind and is of most value as a wind explorer.

A. W. STAHL, M. E., '76, who was in charge, from 1892 to 1895, of the construction of three modern U. S. naval vessels, viz.: The *Monterey*, a monitor of 4000 tons displacement; the *Olympia*, a "protected" cruiser of 6000 tons, and the *Oregon*, a coasting battle-ship of 10,000 tons, exhibited a painting of the *Olympia* and two albums of photographs of the *Monterey* and the *Oregon*, taken on their trial trips.

Mr. Stahl has been engaged during the past two years mainly in the repairing of naval vessels, as well as the designing of heavy gun turrets for three of our battle-ships now being built.

Mr. Stahl also exhibited a copy of a text-book on "Elementary Mechanism," written by himself and Mr. Arthur T. Woods, of which the fifth edition will soon be issued.

This exhibit also included a patent specification for a wave motor and a paper relating thereto. Mr. Stahl has given a great deal of thought to the question of utilizing the power of waves, with a view to handling the wave before it becomes a breaker, the apparatus being therefore placed outside the line of the breakers. Most wave motors have been designed to utilize as much as possible of the power in the surf or the breakers.

PROF. THOS. B. STILLMAN, Ph.D., has designed a viscosimeter which indicates automatically the amount of oil passing through the viscosimeter, and which is adapted to work small quantities of oil. This apparatus is largely used in railway labora-

tories. Besides the viscosimeter Dr. Stillman's exhibit included his "Engineering Chemistry," the first edition of which has only recently been issued.

E. P. THOMPSON, M. E., '78, exhibited copies of his books on "Roentgen Rays" and "Invention as a Science."

HENRY TORRANCE, JR., M. E., '90, mechanical engineer of the Hendrick Mfg. Co., Carbondale, Pa., exhibited drawings of a grain dryer designed to meet the requirements of breweries for disposing of their refuse grain, commonly called "brewers' grains." When dried, these grains are a merchantable article, and can be sold at all times. This dryer is designed to be run with exhaust steam. It avoids the grinding action of other dryers, prevents balling by the tumbling of the grain, and combines maximum heating surface, and therefore capacity, with minimum cost, weight and floor space.

The design represents nearly continual work in the evenings for six months in preparing the drawings, and the experience of experimenting with two other forms, one of which was designed almost entirely by Mr. Torrance.

E. A. UEHLING, M. E., '77, of the firm of Uehling, Steinbart & Co., Newark, N. J., exhibited one of his pneumatic pyrometers and his gas composimeter. These instruments were in operation during the exhibition. The pyrometer measured the temperature of the chimney gases of the Institute's boilers and the composimeter measured the amount of carbonic oxide (CO_2) contained in these gases. (See view Exhibition in Phys. Lab., looking North, extreme left of picture.)

A full description of the pneumatic pyrometer, which will record temperatures as high as 3000° Fahr., was published in the INDICATOR for April, 1894.

The composimeter depends, for its action, upon the absorption of the carbonic oxide by caustic potash, and also utilizes the principle employed in the pyrometer. Connected with both instruments was a Steinbart recording gauge.

Mr. Uehling also exhibited drawings and photographs of his pig iron moulding and conveying apparatus as now in operation at the Lucy furnaces.

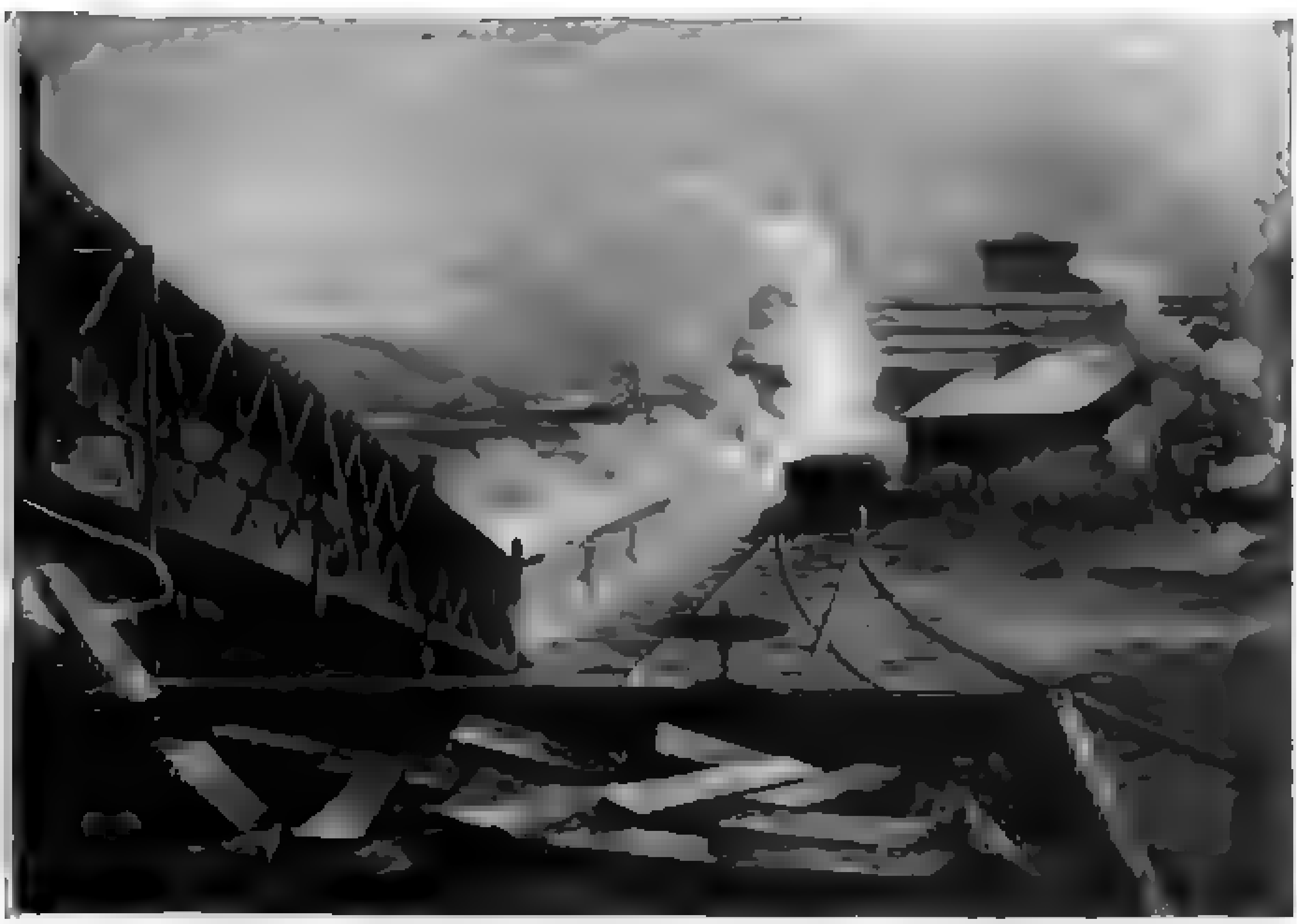
[illegible] *Engineering* [illegible]
[illegible] process:
[illegible] furnaces is draw[illegible]
[illegible] shown in Fig. 1, a[illegible]
[illegible] cast-house" a[illegible]
[illegible] to make it [illegible]
[illegible] moulds in steel [illegible]
[illegible] away from th[illegible]
[illegible] making apparatus [illegible]
[illegible] moulds while shi[illegible]
[illegible] the band as i[illegible]
[illegible] direction o[illegible]
[illegible] the solid and fi[illegible]
[illegible] at right angl[illegible]
[illegible] iron.

This band presently passes under water in a long trough shown to the left in Fig. 2. The water boils violently where the hot "pigs" enter it, but is cooler as they advance, being of course supplied adequately, and then the band carrying the "pigs" rises and turns over at a shute, from which the pigs are delivered into the R.R. cars for shipment to the steel furnaces.

It will be observed that no labor is expended on the iron from the time it leaves the ladle until it is shipped in the car. This means a saving of from 10 to 12 cents a ton.

Again the iron nowhere comes in contact with sand or other injurious substance. The moulds during their return travel in an inverted position are sprayed with a carbonaceous lining mixture which, if anything, improves the condition of the iron cast in them.

In place of an immense surface of sand bed and a corresponding area of the cast house, we have the narrow lines of "endless



UEHLING PIG-IRON PROCESS. FIG. 2.

hands, and in place of the time required in making the pig bed and in cooling and removing the pigs, we have a continuous process by which [illegible] tons of iron per hour can be passed on one apparatus (having two strands of moulds) as shown in Fig. [illegible] from the tap hole of the furnace to the railroad car.

The first experiments with this apparatus were made in the summer of [illegible] at the Lucy furnaces of the Carnegie Steel Co., and in the fall of the same year the apparatus shown in the Figs. [illegible] and [illegible] was constructed and has been in successful operation ever since, with an actual saving in labor alone of $[illegible] a day.

The Carnegie Co. are at present building eight more of these machines for their Duquesne Furnaces, throwing out their electric cranes and pig iron breakers, which, though they operated successfully, do not show favorably either as to cost of handling or quality of product, with the Casting Metal Carrier described above. With such furnaces as these producing from [illegible] to [illegible] tons of cast-iron per day for each furnace, it would be quite impossible to handle the output by the old method.

[illegible] Jr., M. E., [illegible], as chief engineer of the Philadelphia Traction Co., directed the installment of nearly the whole of the power equipment of this company, representing [illegible] H. P.

He exhibited a map of the system of the Philadelphia Traction Co., showing routes of tracks and location of power houses, views of engine and dynamo room, boiler room and exterior of building. Two street views showed the standard side and centre pole construction of the overhead trolley wire system.

Accompanying the exhibit were also tabulated statements of [illegible] and equipment of stations, and of the length of route of the different lines and other general information.

[illegible] M. E., [illegible], exhibited several photographs and [illegible] paintings.

[illegible] Mr. [illegible] devoted himself to fine art [illegible] the Institute, and that his [illegible] the fact that he has been for [illegible] the French Academy and has received [illegible] of the Legion of Honor.

J. Van Vleck, M. E., '84, exhibited several of the edgewise measuring instruments constructed according to his designs. He also showed photographs and models of a triple expansion steam engine, which is known as the Van Vleck engine. See view of the Exhibition in the Phys. Lab., looking North, light colored objects on table left side of view.

H. A. Wagner, M. E., '87, had an extensive exhibit of apparatus designed by him and manufactured by the Wagner Electric Mfg. Co., of St. Louis, Mo. This included a 5 H. P. single phase non-synchronous alternating motor; a direct current motor of $1\frac{1}{2}$ H. P., and a number of the Wagner transformers, ranging from 20 to 500 lights' capacity.

Also switches and cut-outs, including a high potential non-arcing switch; an alternating current Wagner switch-board volt-

meter, with illuminated dial, and photographs showing views of other apparatus and of the shops of the Wagner Electric Mfg. Co.

J. T. WESTCOTT, M. E., '90, exhibited Photographs of Birmingham Gas Works as erected by the Economical Apparatus Construction Co., of Toronto, Canada.

PROF. WEBB exhibited a gyroscope of his own construction, which is operated by means of compressed air at a pressure of 100 pounds per square inch. The advantage it has over other gyroscopes is due to the absence of all disturbing elements in its action. The air is led through the frame and enters the gyroscope at its axis, then passes through disc and out of orifices at the side. Other gyroscopes have been constructed to which the moving force is applied by a pulley ; but this prevents the free motion about its axis.

A panel bridge model was shown with an appliance for running a car on from one or both ends ; if a car is run on from one side only it is heavy enough to break a member of the truss, but if a similar car is run on at the same time from the opposite side the piece will not break.

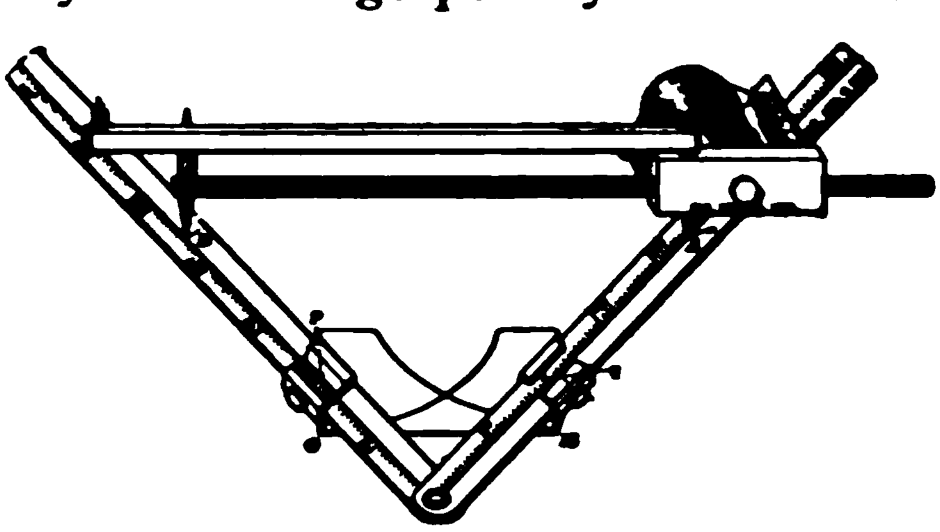
There was also a moment-of-inertia balance by means of which the moment of inertia and centre of gravity of any shaped body can be found very accurately. The exhibit also included two pieces of apparatus for weighing the reaction of water jets. These are described in the *Franklin Institute Journal*, V. 94, p. 144. Prof. Webb also showed balls supported by jets of air, and drawing boards constructed by him. The feature of the latter consists of a method of fastening the paper to the board so that drawing cannot be distorted.

WM. WHIGHAM, M. E., '88, exhibited blue prints of a water spray apparatus designed by him for chilling the surfaces of armor plate, and by means of which a product superior to that obtained by plunging the plate bodily into a bath of water, is secured.

Mr. Whigham has been engaged during the last four years in the development of face-hardening armor and in the improvement of machinery and appliances used in the manufacture of the same.

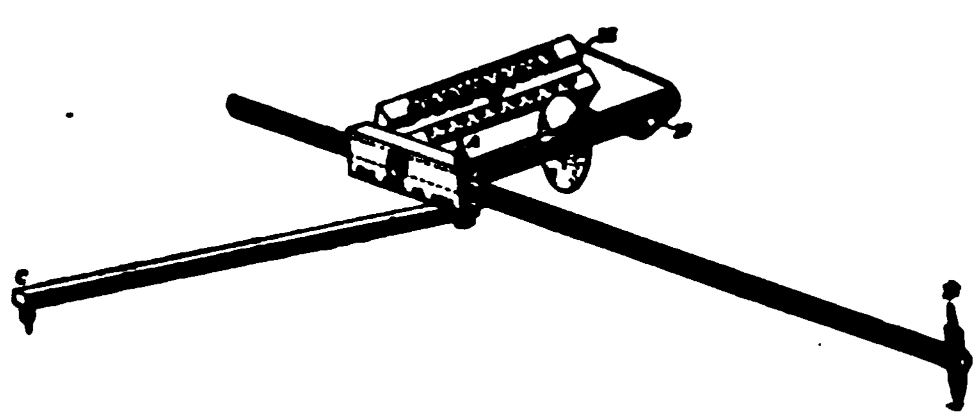
This work was done for the Carnegie Steel Co. ; he has had more or less to do with the technical part of contracts taken by this firm, having been in St. Petersburg for seven weeks during the winter of 1895–96.

A. R. WHITNEY, JR., M. E., '90. This exhibit consisted of: 1. Seven photographs of the exterior and interior of the Nail Manufacturing plant of the Puget Sound Wire Nail & Steel Co., Everett, Wash., a wire nail and keg factory having a capacity of 1200 kegs per day and 60 tons of finished wire. Plans prepared and buildings constructed and equipped during the fall of '91 and spring of '92, by A. R. Whitney, Jr., present Manager.



WILLIS EXHIBIT. FIG. 1.

2. Electric Railway Plant :—Photograph of the interior of the Power Plant of the Everett Railway & Electric Co., the same being a light, railway and power station. Inspected and accepted for the company, and operated and managed for them after completion, by A. R. Whitney, Jr., M'g'r and Treasurer.



WILLIS EXHIBIT. FIG. 2.

3. Sloop Yacht : Photograph of the sloop yacht *Storm King*, designed, modeled, laid down and built—actually constructed—by George E. Montandon and A. R. Whitney, Jr.

LEONARD D. WILDMAN, M. E., '90, exhibited framed pictures of various types of Air and Gas Compressors manufactured by The Norwalk Iron Works Co. of So. Norwalk, Conn., with which company he has been connected from the time he graduated from the Institute.

E. J. WILLIS, M. E., '88. Exhibit : Planimeter for areas, mean pressures and horse-power. This instrument, which was

[illegible]

is only moderately warmed, that is to say, to room temperature, and is not used for heating the rooms, the heating being effected by direct radiators underneath the windows, concealed by screens. All the upper rooms are heated by direct radiation in the same manner by radiators under the windows concealed by screens.

In all the main rooms the Johnson System of Heat Regulation is introduced, so as to automatically insure any desired uniform temperature in the room.

The boiler plant consists of Babcock & Wilcox boilers, aggregating about 3000 H. P. There are two 14" mains from boilers. The exhaust pipe is 20" in diameter.

Every approved modern method and device for saving steam and heat is present in the plant and all pipes are covered with non-conducting material including the risers in the wall behind furring, the branch connections underneath the floors, and the pipes in trenches.

The dynamo engine plant, for which steam is supplied, aggregates 2200 H. P., electricity being used both for lighting, elevator and ventilating service.

The drawings constituting this exhibit had an aggregate area of 250 sq. feet.

JOSEPH WETZLER, '82, had on exhibition a number of volumes of *The Electrical Engineer* of which he is editor, and several books of which he is the author.

PROF. DE VOLSON WOOD exhibited a rock drill made by him about 15 years ago when he was developing his drill. It was found to have some weaknesses and for that reason was never sent to the mines but has been preserved to exhibit the mechanism and mode of operating large ones. The drill and tripod weighs about 75 pounds.

The drawing of a drill which was exhibited, was a working drawing of a size of which many drills were made and sold.

It was made by his late son, Edwin De Volson Wood, about the time he left the Institute.

The home-made barometer exhibited by Prof. Wood was a recent invention. It consisted chiefly of a pine stick half an inch square, 8 or 10 inches long, pivoted near one end and balanced by

In addition to the exhibits contributed by the faculty and alumni as above enumerated there were sent to the Institute by Col. E. A. Stevens a number of interesting models representing: 1st, the Stevens Battery as designed and partly constructed by Robert L. and Edwin A. Stevens, the elder; also, 2d, a model of the *Naugatuck*, a small vessel rebuilt and fitted out by Edwin A. Stevens for use against the *Merrimac* during the war of the Rebellion; and 3d, a model representing the *Maria* as altered from a sloop into a schooner by Edwin A. Stevens; and 4th, a model on a very large scale and complete in every detail, inside and out (a portion of the hull being cut away to expose to view all the interior machinery), of the *Hamburg*, one of the latest of the double-ended ferry-boats, with screw propellors at each end

EXHIBITION IN LIBRARY LOOKING WEST.

and compound engines, designed and adopted on the New York and Hoboken ferries by Col. E. A. Stevens. As an almost amusing companion to this was a model of the twin screw boat which ran between New York and Hoboken in 1804, having been built at that date by John Stevens.

This model was secured from the National Museum at Washington through the kindness of Mr. J. E. Watkins.

The accompanying half-tone plate shows these models as they stood during the exhibition in the Library. Four of them are on the table in the middle of the picture, and the large ferry-boat model is in the elevated glass case immediately beyond this table.

There were also several exhibits by undergraduates.

W. A. KIRKLAND, '97, contributed a gas engine built by him in the Institute's shops.

W. STRANG, '98, a dynamo, and H. A. KORNEMANN, a dynamo and motor, also built by them at the Institute.

W. PRYOR, '97, exhibited a tandem bicycle constructed by him from parts purchased in the market.

During the exhibition the rooms of the various departments of the Institute were thrown open for inspection.

In the drawing rooms the regular work upon which students happened to be engaged at the time was displayed, as well as finished drawings representing the work of the different years of the course in this department.

As indicated by the above brief descriptions the exhibition was large and interesting beyond anything which could have been anticipated, though beyond doubt many more exhibits of equally high character and scientific interest would have been presented had more time been available for the preparation of the same.

RECEPTION OF MRS. EDWIN A. STEVENS.

Mrs. Edwin A. Stevens received the trustees, faculty, alumni and undergraduates and their ladies at Castle Point on Friday afternoon, Feb. 19th, from 3 to 6 o'clock.

Mrs. Stevens was assisted by Mrs. Henry Morton, Mrs. C.

or two with songs and other music, each number being enthusiastically received and nearly all receiving encores.

During an intermission in the concert Professor Kroeh announced the awards of prizes offered by President Morton and Professors Bristol, Jacobus and Anderson, amounting to $50 in all, for photographs shown at the anniversary exhibition. The judges, President Morton, Mr. Dod, Mr. Pach and Mr. Turner, the artist, made the following awards:

First Prize, William Ebsen, '90.

Second Prize, J. Stehlin, '98.

Third Prize, H. M. Brinckerhoff, '90.

Fourth Prize, E. N. Wood, '97.

Fifth Prize, Wm. M. Shoudy, '99.

The concert ended with the song, "Mechanical Engineer," sung and played by the united musical clubs and by many of the audience, and at its close the hall was cleared of chairs and the dancing began. This was at first difficult, owing to the large crowd present, but along towards midnight the crush diminished, so that those remaining were able to thoroughly enjoy the dancing, which some of the more enthusiastic dancers did until the morning was well advanced.

Altogether the concert and dance was a great success and a fitting close of the glorious anniversary celebration. A partial list of the alumni who were present, some with their ladies, follows:

'76.
A. P. Trautwein.
P. E. Raqué.
Gus C. Henning.
A. Riesenberger.

'77.
L. H. Nash.
F. E. Idell.
E. P. Roberts.

'80.
J. W. Lieb, Jr.

'81.
Alex. C. Humphreys.
R. M. Dixon.
A. Spies.

'83.
H. A. Hickok.

'84.
Wm. H. Bristol.
D. S. Jacobus.
C. W. Thomas.
H. F. Mitchell.

'85.
Edw. Burhorn.
B. H. Coffey.
A. W. Burchard.

'86.
Wm. R. King.

'87.
M. C. Beard.
J. H. Cuntz.
B. F. Hart.
E. H. Kiernan.

'88.
Geo. Dinkel.
A. A. Fuller.
H. A. Bang.

'89.
H. L. Ebsen.
W. M. Hill.

'90.
H. M. Brinckerhoff.
J. L. De Hart.
E. E. Hinkle.
L. D. Wildman.

'91.
Wm. S. Ackerman.
C. G. Atwater.
C. E. Pearce.

'92.
A. R. Hake.

'93.
H. F. Cuntz.
F. D. Furman.
H. E. Griswold.
Henry Kopp.
J. V. MacDonald.

'94.
Jos. Cottier.
J. B. Klumpp.
A. G. Kollstede.
H. D. Lawton.
C. W. Mac Cord, Jr.
L. Ruprecht.

'95.
Percy Allen.
M. E. Craft.
A. F. Ganz.
C. A. Greenidge.
B. H. Jackson.
E. Kemble.
J. N. MacVeety.
F. N. Taff.

'96.
Wm. H. MacGregor.
Edw. M. Toby.

DESCRIPTION OF EXHIBIT OF MR. J. F. KELLY, B. S. '78.

This exhibit consisted of a

40 K. W. Two Phase Generator with Regulator Head,
2 K. W. Two Phase Induction Motor,
2000 Volt Static Ground Detector,
10,000 Volt Static Ground Detector,
Static Voltmeter,

being component parts of the S. K. C. (Stanley-Kelly-Chesney) system as manufactured by the Stanley Electric Manufacturing Company of Pittsfield, Mass., to which company Mr. Kelly is consulting electrician. A detailed description of this apparatus is given below.

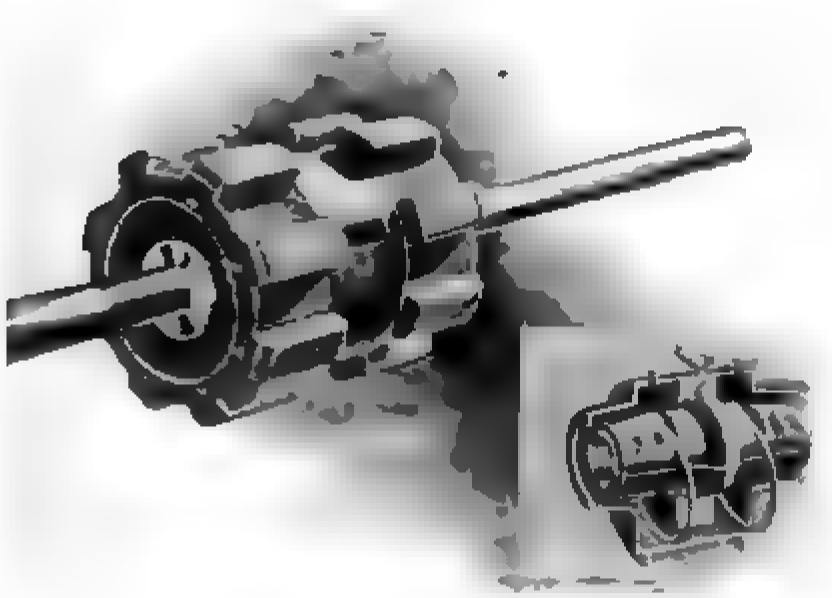
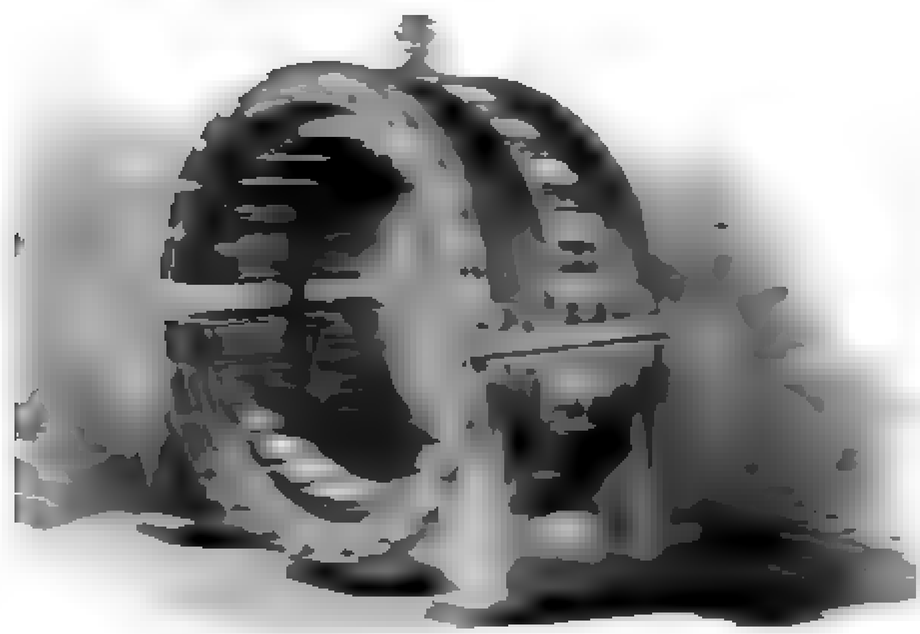


FIG. 1.

Generator.—The electrical design of these generators is always the same but the mechanical construction varies in the different sizes. Its two most important features are simplicity and strength as it has no moving wire, no collector nor commutator. The revolving part of this machine is really the field, but is more properly called the Inductor. (Fig. 1.)

This is made of steel casting upon the periphery of which polar projections of iron laminæ are securely fastened and which revolves within the stationary armatures.

The armature (Fig. 2) is made up of iron laminæ and constitutes the body of the machine. The individual coils are small and are wound separately on forms and are then secured in grooves provided for them in the laminations. Being small and



of this regulation by varying at will the length of effective wire. Thus without loss of energy or material complication, this two-phase machine becomes practically similar in operation to two single phase machines. Wires are brought out from the armature to the regulator head, which in the machine shown at the exhibition was combined with the terminal board, but which may be placed on the switch-board if so desired, where by means of handles the voltage on either phase may be raised or lowered or set at any desired point.

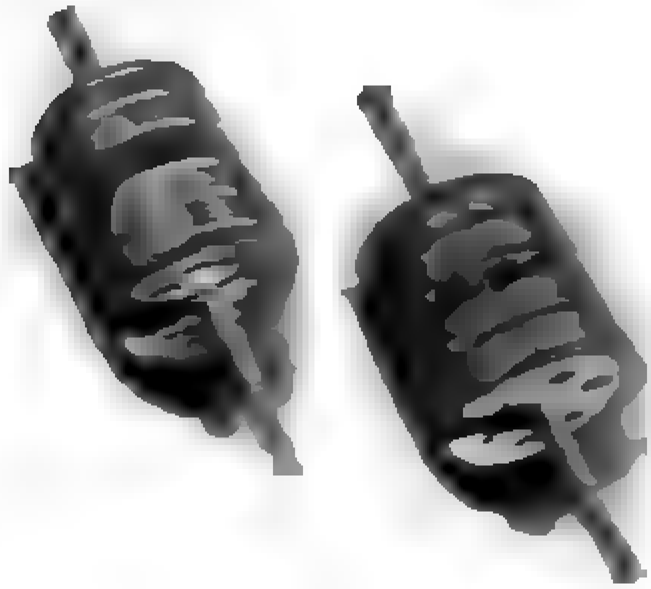
In the operation of alternating current motors, and also of transformers, it is now generally recognized as important that the currents and magnetic fluxes, should vary sinusoidally, for the more nearly such a condition is approached, the less are the losses and false currents. A first step toward obtaining these conditions is the making of the impressed E. M. F. of the generator sinusoidal.

FIG. 3.

The flux between a field pole and the opposite iron of the armature distributes itself so that it is at every point inversely proportional to the reluctance of the gap at that point. That is, the E. M. F. at any instant is inversely as the clearance between the armature iron and the inductor pole. In order, then, to obtain an E. M. F. following the sine law, the pole faces of the inductors of these generators are so shaped that their curvature may be expressed by a formula which was derived by Mr. Kelly and is contained in a United States patent issued to him.

As has been stated above, any deviations from this law or the use of any other than a sinusoidal form of E. M. F. has resulted in increased losses in transformers and unsatisfactory running of motors. In one instance the output of a 20 H. P. motor was reduced 25 per cent. when run by a machine giving a distorted wave, and the condensers which were intended to balance the lagging currents of the motor were absolutely useless for that purpose.

[illegible] Fig. [illegible] armature [illegible] which the [illegible] electrical connection with each other [illegible] by the [illegible] are [illegible] The [illegible] The number of turns [illegible] the [illegible]



[illegible] The armature [illegible] length of the [illegible] as there are poles [illegible] the first groove the winding [illegible] is the same as that between [illegible] that returns to the [illegible] and the width of

each winding of the coil is equal to the the width of the pole, thus leaving vacant on the surface of the armature an equal space between. After the first series is wound, the alternating vacant spaces mentioned above are similarly occupied by another series.

The armature winding is closed on itself and is not connected with the circuit, and consequently the only current flowing in it is an induced current of low E. M. F. When the currents have a phase difference of 90° one current is at its maximum when the other has zero value; this latter current, however, then has its maximum inductive action, the rate of change being maximum when the current passes through zero. If a pole of the zero circuit (which has no polarity) is opposed to the central opening in an armature section, its inductive action will produce a strong current in this section, which will also flow over the two poles of the other field, which at this time have a maximum strength due to the maximum current in their coils. This will produce a torque exactly as in the case of a continuous current motor, the condition in regard to the field and armature current being the same. As a coil moves out of this position of maximum torque its current as well as the strength of the motor poles become weakened, but at the same time the second series of coils begins to gather strength and they finally reach their maxima when those in the first exert no torque.

It is thus seen that one field and one-half of the length of the armature act as a transformer to furnish the current for the other half of the armature which with the other field forms a motor and *vice versa*.

Thus far it has been assumed that the armature currents are in phase with their E. M. F.'s and practically that the armature is without self-induction. This, however, is not the case, and the self-induction causes the armature current to lag, and thus not to be in the best position to cause rotation. The necessity of neutralization of the self-induction of the armature of A. C. motors is apparent in all types and it is accomplished in the S. K. C. motor by the use of compensating coils as mentioned above, which is the invention of Mr. Kelly.

The reaction of the armature current induces currents in the

[illegible] compensating system, which act opposite [illegible] effect.

[illegible] polyphase induction motors there is a magnetizing [illegible] of considerable magnitude which lags behind its E. [illegible] and is therefore not in a position to do much work. This [illegible] the transformers, lines and generator and worse, this [illegible] current increases the reaction of the armature on [illegible] of the generator so that its capacity is reduced.

[illegible] current [illegible] behind the E. M. F. and the cur- [illegible] condenser is [illegible] ahead of the E. M. [illegible] current [illegible] motor is furnished [illegible] condensers. Two condensers are connected in multiple with the leads of the motor and each has a capacity in amperes at the [illegible] practically equal [illegible] current of each [illegible] the motor [illegible] in the current wire. [illegible] induction motor with condensers [illegible]

[illegible] condensers on induc- [illegible] New England. The [illegible] machine manufactured by [illegible] and was furnishing power [illegible] The amount of current [illegible] amperes at [illegible]

[illegible] condensers the current [illegible] and the power factor was [illegible] The [illegible] being in- [illegible] in the curve of [illegible] machine in use.

[illegible] — This [illegible] shown in [illegible] differential [illegible] meter [illegible] and a [illegible] made of sheet [illegible] two [illegible] The [illegible] each pair is [illegible] of electrical supply. [illegible] earth is inductively

acted upon by each pair of fixed vanes so that the stress produced by each is equal but opposite. The movable vane in consequence takes a position equally between the fixed vanes which position is, theoretically, the same whether the instrument is charged or not, and is the position of "no ground," the pointer pointing to the zero of the scale.

If one pair of fixed vanes and the movable vane are electrically connected, they are charged of like character from one pole of the source, the other fixed vanes being charged of opposite character from the other pole. The action of the similarly charged vanes is to repel the movable vane while the action of the other fixed vanes is to attract it. The two forces acting in the same direction, the movable vane takes the position entirely within the oppositely charged vanes. The pointer pointing to the side of the similarly charged vanes and pointing to the position of "ground" for that side.

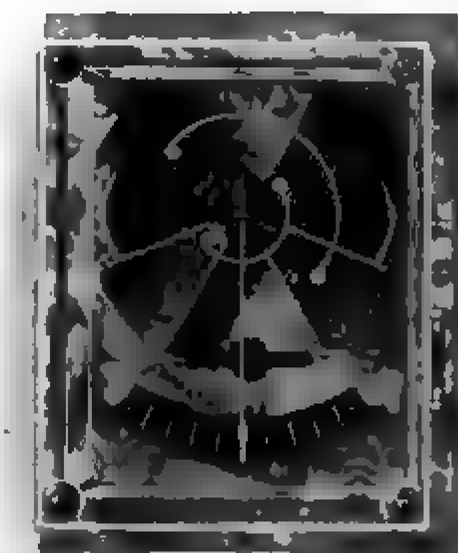


FIG. 6.

There is no connection through the instrument between the line wires or between either of the wires and earth. It is not necessary to first introduce a temporary ground on the line in order to test for an existing ground, the characteristic defect of the old forms of ground detectors. This feature is of great importance as it insures greater safety to linemen and lessens the possibility of short circuits in the instrument itself.

The instrument consumes no energy and may be left continuously in circuit, indicating grounds as soon as they occur.

The 10,000 volt instrument differs in construction from the 2000 volt Ground Detector in that the line wires are connected to a primary set of vanes which are behind the visible fixed vanes and are separated from them by large plaques of hard rubber.

PERMANENT EXHIBITION AT THE INSTITUTE.

In response to a notice, which was sent to the exhibitors at the Anniversary Exhibition, stating that the establishment of a permanent exhibition at the Institute was contemplated, a considerable number of donations for this purpose have been received, being in some cases part and in others all of the exhibits shown on the above occasion.

Some of the photographs and drawings presented will be hung, in frames, upon the walls in different parts of the Institute building and suitable provision will be made for preserving and exhibiting the others. Space has also been provided, and will be added to from time to time, where models, etc., which have been presented and which may be presented hereafter for the permanent exhibition can be placed.

The following is a list of the contributors and their contributions to the permanent exhibition:

C. J. Atwater, '91, Set of Photographs of Coke Ovens.

J. S. Alden, '84, Pamphlet on Theory of Matter.

Wm. O. Barnes, '84, Photographs of a Steel Type-Engraving Machine.

H. M. Brinckerhoff, '90, Photographic Views of the Intramural Railway of the World's Fair and of the Metropolitan West Side Elevated Railroad at Chicago.

Wm. H. Bristol, '84, Lecture Model of Recording Thermometer for high temperatures.

Edwin Burhorn, '85, Set of Photographs of Power Plant, Dodge Coal Storage System for Erie R. R., East Buffalo, N. Y., and Set of Plans for new proposed boiler plant at Ridgewood Pumping Station for city of Brooklyn, N. Y.

Morgan Brooks, '83, Drawing of an Automatic Telephone System for Villages.

B. H. Coffey, '85, Photographs of a Dredging Plant.

F. N. Connet, '89, Patent Pull Universal Belt Shifter.

Wm. Whigham, '88, Blue Prints of Water Spray Apparatus for Tempering Armor Plates.

A. R. Whitney, Jr., '90, Photographs of a Wire Nail Plant.

L. D. Wildman, '90, Set of Framed Photographs of Drawings of Air Compressors.

E. J. Willis, '88, A Willis Planimeter for areas, mean pressures and horse-power.

Prof. Wood, A Rock Drill.

A. J. Wurts, '84, A frame containing samples of Non-Arcing Lightning Arresters and a frame of Photographs of his inventions of Switch-Board Apparatus and of Medal received.

[illegible]

[illegible] with [illegible]

[illegible]

[illegible]

[illegible] Institute [illegible]

[illegible]

[illegible] with the Riker [illegible]

[illegible] the Institute the [illegible]

[illegible] the National Meter [illegible] builders of the engine, who

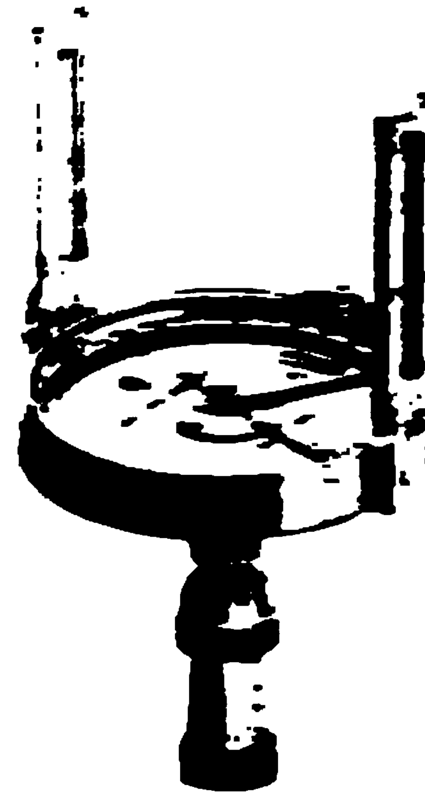
20 H. P. NASH GAS ENGINE

have made a concession in the cost of the engine amounting to $700.

This contribution is prompted by the interest in the success of the Institute taken by the above Company, with which Mr. L. H. Nash, '77, the inventor and designer of the engine, is connected. The regular price of the engine is $1400 which has ac-accordingly been reduced to $700.

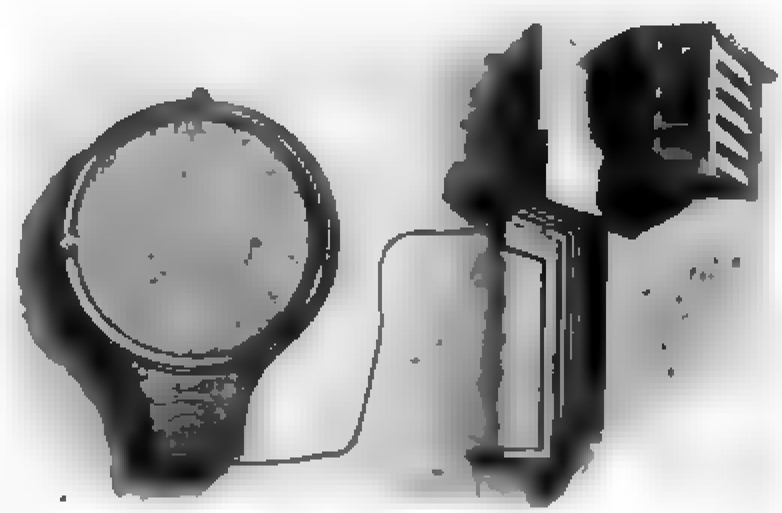
The regular price of the dynamo is $550. A reduction of $100 has been allowed by Mr. Riker on this price so that the cost of the engine and dynamo is reduced from $1950 to $1150.

About 45 members of the class of '97 have contributed towards the purchase of this plant. Handsome contributions have also



Another gift recently made to the Institute is the large balance added to the equipment of apparatus in the physical laboratory. This balance is remarkably sensitive, it being possible to measure with it a difference in weight of one milligram in one million.

It was purchased at a cost of $412, which sum was almost entirely contributed by Professor Mayer, President Morton and 26 members of the Class of '96.



Prof. William H. Bristol, '84, and Mr. B. B. Bristol, '93, for The Bristol Company of Waterbury, Conn., presented the Institute with a Recording Thermometer for measuring atmospheric ranges of temperature.

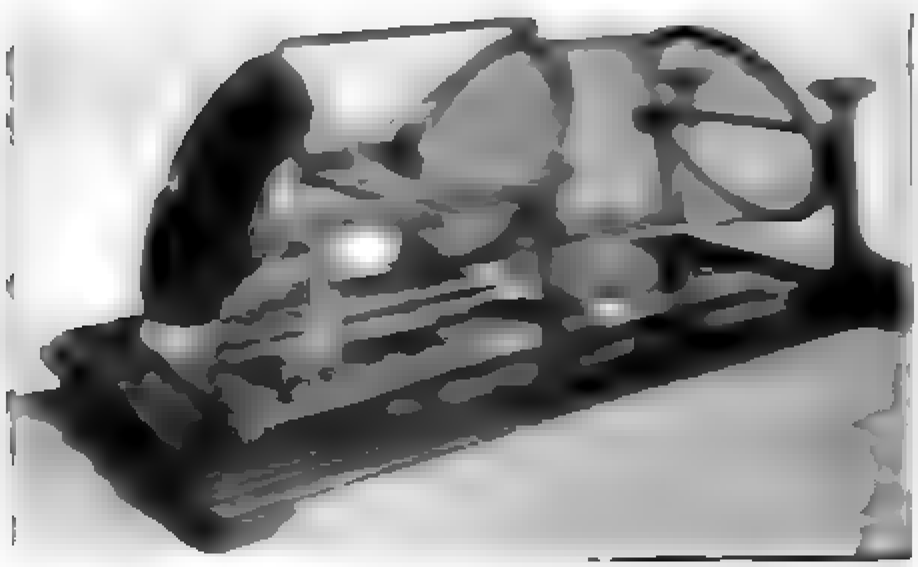
The recording part of the instrument has been mounted on wall in vestibule at the main entrance to building and makes a continuous record of the temperature out of doors.

A NEW OLIVIER MODEL

[illegible]

The accompanying engraving represents the latest addition to the series of Olivier models described in the preceding issue of the [illegible].

This model consists essentially of three string [illegible] each of which is mounted on trunnions so as to be capable of turning through a limited arc about a horizontal axis. The three axes lie in the same horizontal plane and are parallel to each other. The



[illegible] fixed frame [illegible] that they [illegible] [illegible] the right [illegible] the [illegible] the

horizontal axis of its trunnions. The rack is fixed to the bed-plate, and the pinion-shafts (which are turned by the milled heads seen at the right) have their bearings in the movable frame; the latter, then, can be placed in any desired position, independently of the turning of the circles on the trunnions.

The cords are fixed in holes drilled at regular intervals in the right-hand circle, pass directly to corresponding holes in the central circle, thence (crossing each other) to corresponding holes in the circle at the left, and turning abruptly around the smooth edge of this circle, are attached to the springs which keep them taut; the proper range of motion being regulated by the use of pulleys or their equivalents, as in the cases previously described.

A very striking peculiarity of this model, however, is found in the manner in which these springs are arranged:—instead of being attached to the frame, they are fixed to, and radiate from, a central hub which forms a part of the left-hand circle and moves with it.

The saving of space effected by this expedient, as compared with a fixed base of attachment or with the use of weights, is enormous—as the incredulous may convince themselves by experiment.

Now suppose the three circles to be vertical, and placed with their centres in line, then we shall have on the left of the middle circle a right conoid; and on the right, a cylinder of revolution—which may be changed into an elliptical cylinder by moving the more remote base sideways in the manner above explained. Restoring that circle to the first position, let the other two on the left be inclined, as in the figure; the original conoid is thus transformed into a different one, while the circular cylinder becomes a warped surface with a vertical plane directer parallel to its axis; and by the lateral movement of the farther base this will be changed into a different warped surface which has no plane directer.

Once more placing the centres in line, turn the farther circle on its trunnions until it and the central one are equally inclined in opposite directions, as shown in the illustration. The portion on the right will then become an elliptical cylinder, divided from the circular one in a different way ; and this if the farther base be moved laterally will be transformed into a cylindroid, which is also a warped surface without a plane directer.

Thus, by various combinations of the simple motions of which the parts of this model are capable, we are enabled to exhibit not only the peculiarities of quite a number of surfaces, but what is equally important, the manner in which one of these may be transformed into another; this last, as we have seen, may sometimes be accomplished in more ways than one.

In brief, we have as directrices three equal circles, of which two can be moved in one way, and the other one in two ways—with the result of illustrating five warped surfaces, belonging to three distinct classes ; and three single-curved surfaces, all of the same class, two of them being derived from the first by different methods.

INSTITUTE NOTES.

LECTURES ON BUSINESS METHODS AND ON PATENT LAW. A course of three lectures on "Business Methods" was delivered to the Senior Class near the close of the second term. The first lecture, which was introductory in its nature, was prepared by Mr. Alexander C. Humphreys, '81, but owing to his absence from the city, on account of ill-health, Mr. H. de B. Parsons, '84, presented Mr. Humphreys' paper. Mr. Parsons also addressed the class giving his own views upon the importance of a knowledge of the proper methods of keeping accounts, and upon the position of the engineer as viewed from a business rather than a professional standpoint.

The second lecture was given by Mr. George Turnbull, Vice-President of the Guarantee Trust Co., of New York City, on the subject of "Double Entry Bookkeeping," and the third lecture, upon "Banks and Banking," was delivered by Mr. Wm. Sherrer, Manager of the New York Clearing House.

The attendance was large and included a number of alumni.

The lectures will be published in the July issue of the INDICATOR and will no doubt be of interest to alumni.

Following the course of lectures on "Business Methods" Richard A. Dyer, Esq., of the firm of Dyer & Driscoll, Patent Solicitors, New York City, delivered a course of lectures on Patent Law covering substantially the same ground as last year.

THE MEMORIAL VOLUME OF THE 25TH ANNIVERSARY OF THE INSTITUTE:—President Morton is devoting a good part of his time to the preparation for publication of matter to appear in the souvenir volume commemorating the 25th anniversary of the founding of the Institute.

The collection and preparation of the articles and cuts which the book is to contain will involve a considerable amount of labor, so that under favorable conditions the volume will not be ready for distribution before commencement time.

The Literary Committee would again call attention to the fact that a record of the professional work of graduates is being prepared in the form indicated in the sample pages published in the last INDICATOR, and the committee requests all graduates who have not yet furnished information for this purpose to comply with its request as it is very desirable to have the record as complete as possible.

The Committee also request all alumni and undergraduates who desire copies of the book to send in their subscriptions. The alumni and undergraduates who are entitled to copies, in return for their contributions to the preliminary expenses of the anniversary celebration, but who

[illegible]

[illegible] the committee [illegible]

[illegible] Matter

[illegible]

[illegible] Electrical Engineer

[illegible]

[illegible]

[illegible] page illustrated article [illegible]

[illegible] The [illegible] the degree of Doctor of Laws. This degree will [illegible] ex-President Cleveland. [illegible]

[illegible] degree of Master [illegible] conferred upon [illegible] New Jer- [illegible]

[illegible] in this with [illegible]

[illegible] of Maplewood, N. J., [illegible] the Institute until next September [illegible]

[illegible] the successful in- [illegible] Niagara to Buffalo held [illegible]

[illegible] was regarded by the [illegible] triumphs of the century.

[illegible] entitled "An Experimental In- [illegible] in the Flotation of Disks [illegible] Measurement of Surface Tension," which is

published in the *Amer. Jour. of Science* for April, 1897, PROF. MAYER gives references to the earlier literature on this subject and a full account of his own experiments which were made principally upon disks and rings of aluminum. He also experimented with several other metals and upon glass rods.

AN ACCOUNT of "A Comparative Test of Two Centrifugal Fans," made by PROF. DENTON, was read, for the purpose of inviting discussion from members, at the meeting of the Amer. Soc. of Heating and Ventilating Engineers. An account of the meeting appeared in *Heating and Ventilating*, March 15, 1897.

THE DIGEST OF PHYSICAL TESTS for April, 1897, contains the complete article on Paint Analysis as it appears in Dr. Stillman's book "Engineering Chemistry." The same issue of *The Digest* contains also a short scheme for analyzing paint, contributed by Dr. Stillman, adapted for railway practice.

This scheme suggests a method for determining the relative proportions of hydrated and carbonate of lead in white lead, either dry or ground in oil.

PROF. JACOBUS delivered a lecture at the Franklin Institute, Philadelphia, March 12, 1897, on Artificial Light: Modern Methods Compared: Electric, Incandescent, Welsbach, Acetylene.

An abstract of the lecture is published in *Progressive Age*, April 1, 1897.

Prof. Jacobus illustrated the comparative value of the Welsbach incandescent gas light and the acetylene light, in rendering colors and shades of colors, demonstrating that these modern illuminating methods were greatly superior in this respect to coal-gas and the incandescent electric light, and that there was very little difference between them.

IN THE *Cosmopolitan Magazine* for April appeared the introductory article by J. Brisben Walker, of a series of articles on "Modern Education." This will be followed in the May number of the same journal by an article on the same subject by President Gilman of the Johns Hopkins University. In the June number will appear the next in the series by President Morton, and others by President Dwight of Yale, President Schurman of Cornell, and Bishop H. C. Potter of New York will follow.

PROFESSOR AND MRS. KROEH gave a reception on February 27th, at their new home in Orange, on the occasion of the twenty-fifth anniversary of their marriage.

They received the congratulations of their many friends, who were pleasantly entertained by the host and hostess and the ladies assisting.

The members of the senior class were among those who offered their congratulations upon the day.

MINUTES OF REGULAR MEETING of the Executive Committee of the Alumni Association held at the office of Mr. R. M. Dixon, 160 Broadway, N. Y. City, April 1, 1897.

Meeting called to order by Mr. R. M. Dixon, 2d Vice-President.

In the absence of the Recording Secretary. Mr. F. De R. Furman was appointed, *pro tem.*

Professors Riesenberger and Stillman tendered their resignation as co-editors of the INDICATOR, to take effect with the issuing of the April (1897) number. On motion of Mr. H. De B. Parsons these resignations were accepted with regrets.

After some discussion as to the editorial and financial policy of the INDICATOR, Mr. Furman was regularly appointed editor, with full power to pursue such policy as may be deemed to be to the best interests of the INDICATOR.

The following nominations for officers for the ensuing year were made; several substitutes were appointed to take the place of any who should decline their nomination:

President,	John W. Lieb, Jr, '80.
	Edwin Tatham, '81.
	Edward P. Thompson, '78, Substitute.
1st Vice-President,	Robert M. Dixon, '81.
	Edwin Burhorn, '85.
	A. P. Boller, Jr., '91, Substitute.
2d Vice-President,	Hosea Webster, '82.
	George Dinkel, Jr., '88.
	William B. Vereance, '88, Substitute.
Corresponding Secretary,	Franklin De R. Furman '93.
Recording Secretary,	Gordon Campbell, '88.
	John S. De Hart, Jr., '90.
Treasurer,	William H. Bristol, '84.
Directors,	Ernest H. Foster, '84.
	William R. King, '86.
	Alten S. Miller, '88.
	William O. Ludlow, '92.
Alumni Trustee,	Lewis H. Nash, '77.
	E. P. Roberts, '77.
	Frank C. Jones, '78.

Those present at the meeting were: P. E. Raqué, F. E. Idell, E. A. Uehling, R. M. Dixon, W. H. Bristol, H. De B. Parsons, Kenneth Torrance, and F. De R. Furman.

ENGINEERING SOCIETY. The First Meeting of Second Term, 1896-97, was held on Friday, Jan., 8, 1897, at 2 P. M. Officers were elected as follows: President, E. R. Knapp; Vice-President, R. V. Rose; Secretary, E. Steinbrügge; Executive Committee, Jacob Cromwell, G. D. Williamson, E. C. Grelle.

R. V. Rose, '97, read a paper on "A Method of Utilizing the Power at Niagara." M. N. Moore, '98, explained the practical working of the Westinghouse Air Brake.

At the Second Meeting of the Society, on Friday, Feb. 5, 1897, Col.

G. Prout, member of the Amer. Soc. C. E., delivered a very interesting address on "The Development of the Steel Rail."

At the last meeting, G. L. Hutchins, '97, gave an interesting description of Steel at the Carnegie Steel Works, Homestead, Penn. O. M. Kelly, '97, talked on the recent developments of River Tunneling, including description of Tunnel under the Thames River, as well as the method employed in its construction.

J. Cromwell, '97, and J. M. Towne, '97, reviewed the electrical and mechanical journals, respectively.

THE JUNIOR BALL was held Wednesday, Feb. 17th, at Delmonico's, New York City. The success of the promenade was very gratifying to the committee, Messrs. F. D. Kennedy, E. Frank, Jr., H. R. Davis, R. C. Post, and E. C. Grelle, who had charge of the arrangements.

THE SENIOR CLASS made their annual eastern inspection tour to Hartford, Conn., on March 25th, accompanied by Prof. Denton.

The class visited the works of the Pope Manufacturing Co. and The Pratt & Whitney Co.

INSTITUTE PERSONALS

The [illegible] of the Gas Industries Company held at the Madison Square Garden in January was attended by the following graduates of the Institute:

[illegible] J. [illegible] M[illegible]n, [illegible] Harpence, J. B. Klumpp, Alten S. [illegible] M. [illegible] J. M. [illegible] W. F. Lawrence, [illegible] J. Roberts and Wm. H. [illegible].

President Morton and Alex. C. Humphreys, who are members of the [illegible] of the Company, also visited the exposition.

[illegible] and [illegible] attended the meeting of the [illegible] Light Association held [illegible] and [illegible] in the Madison Square Garden Assembly Room, and participated in the discussion of the subjects presented to the meeting.

From the list of [illegible] published in the January INDICATOR which [illegible] the active and associate members of the Alumni Association who are subscribers to the INDICATOR, the name of WM. W. RANDOLPH, '[illegible], was by mistake omitted.

J. M. W[illegible], whose appointment as General Supt. of the Philadelphia [illegible] and Northern Central Roads was recorded in the last INDICATOR, began his railroad life as an apprentice in the shops of the Northern Central [illegible] at Baltimore, Md., in [illegible], and has filled positions of assistant road [illegible], assistant engineer [illegible] superintendent of motive power of the Northern Central, superintendent of motive power of the [illegible] and superintendent of motive power of the [illegible].

[illegible] of the new officers of the Amer. Soc. of Mech. Engineers [illegible] includes one of Geo. C. HEN[illegible] [illegible] He is referred to as one [illegible] with [illegible] the chemistry of iron and steel being one [illegible] at work on valuable experiments [illegible] as inspector of materials [illegible] has especially fitted him for his present [illegible] engineer.

[illegible] have recently published descriptions, with [illegible] of John [illegible] This instrument, [illegible] very efficient in practice.

[illegible] Engineer of Mar., [illegible] the Lake Shore and Mich. So.

R'y. When a light fall of snow does not warrant the sending out of snow plows, a scraper or flanger is used. A notable feature of the one described by Mr. Antz is its operation by compressed air.

A communication by JOHN W. HOWELL, referring to the "Radiating Power of Incandescent Lamp Filaments" was published in *The Electrical Engineer*, Jan. 6., 1897.

Mr. Howell's paper, presented at the meeting of the Amer. Inst. of Electrical Engineers, in New York, Feb. 24, 1897, on the "Conductivity of Incandescent Carbon Filaments and of the Space Surrounding Them" is published in the issues of March 17th and 24th, of the same journal.

'79.

PHILLIP WALLIS has been appointed Master Mechanic of the Lehigh Division of the Lehigh Valley Road and of the Eastern & Amboy R. R., with office at Easton, Pa.

'80.

At the January meeting of The New York Section of the American Chemical Society DURAND WOODMAN presented a paper on "Variations in the Composition of Red Lead."

'81.

WM. T. MAGRUDER, in *Cassier's Magazine* for March, 1897, under the Title of "Does it Pay to Exhibit," tells under what conditions the display-ing of manufactures, etc., at exhibitions pays.

ALEX. C. HUMPHREYS, retiring President of the American Gas Light Association, delivered an address to this Association at its annual meeting held Oct. 27–29, at St. Louis, Mo. The address dealt with the business side of gas manufacture and discussed ways and means for increasing the consumption of gas by increasing its use for heating purposes. In commenting upon the address the *American Gas Light Journal* says: "It bristles with well put points, and its lines reveal to the reader the undeniable fact that its scholarly author neither stinted study nor time in its preparation."

'83.

FRANK A. MAGEE, who has been connected for many years with the E. S. Greeley & Co., is now with the Revere Rubber Co.

The *American Engineer, Car Builder and R. R. Journal*, March, 1897, published a full page engraving and a description of the large compound mastodon or 12-wheeled engines built for the Northern Pacific R. R. by the Schenectady Locomotive Works.

The intercepting and separate exhaust valves of the engine are of new design recently perfected by A. J. Pitkin, Vice-President and General Manager, and J. E. SAGUE, Mechanical Engineer of the Company.

The valves are designed to give an independent exhaust to the high pressure cylinders when the locomotive is working as a simple engine and also to give the engineer control of the intercepting valve so that he can operate the engine simple or compound at will.

Mr. Sague is quoted in a paper by C. H. Quereau, presented to the Western Railway Club, as favoring a reduced lead in locomotives for high speed work and gives the practice of the Schenectady Locomotive Works with regard to passenger engines recently built by this Company. Engines having 6″ valve travel and 1⅛″ outside lap, with a plain valve, ¼″ lead at 6″ cut off gave satisfactory results.

In an article contributed to *Electricity* of March 10, 1897, MORGAN BROOKS endeavors to show that the Berliner patent, for a combined telegraph and telephone, to which The American Bell Telephone Company claims ownership, is void by reason of an expired English patent covering the same ground.

'84.

The *American Electrician* of December, 1896, contains an interesting article by PROF. WM. S. ALDRICH on "Compressed Air in Railway Work." The writer calls attention to the various fields in which compressed air has been successfully applied and dwells at length upon its adaptability for street railway purposes.

A. J. WURTS delivered a lecture at Sibley College, Ithaca, N. Y., on "The Handling of Electric Currents, Arcs, etc." An abstract of the lecture appeared in The Sibley College *Journal of Engineering*, March, 1897.

'85.

WM. T. CLERK was married to Miss Eleanor Doubleday, on Thursday, Feb. 4, 1897.

'87.

The Electrical Engineer of Feb. 17, 1897, contains an article with cuts showing views of the products and of the several departments of manufacture of the Wagner Electric Mfg Co., of St. Louis, Mo. Mr. H. A. WAGNER is President of this Company.

The paper by CARTER H. PAGE, JR., on "Some Experiments in Interior Illumination," presented at the St. Louis meeting of the Amer. Gas Light Assoc. in October, 1896, is published in the *Amer. Gas Light Jour.* of Nov. 16, 1896, with an interesting discussion by ALEX. C. HUMPHREYS, '81, bearing upon the question of the difference between candle power and illuminating effect.

'88.

H. R. SMITH announces in a circular letter, recently issued, that he has opened an office for the practice of mechanical engineering at 759 Rookery, Chicago, Ill. Mr. Smith has had a large experience in designing and erecting hydraulic, steam, and electric elevator and hoisting plants, having been connected with both the Hale and Winslow Bros. Elevator Companies.

T. A. VAN DER WILLIGEN has entered the employ of Messrs. Humphreys & Glasgow, in London, and has recently been engaged in the erection of a water gas plant of a 350,000 cu. ft. daily capacity for this firm.

LEWIS SEARING makes an interesting and pointed reply in *The Electrical Engineer*, Jan. 27, 1897, to a criticism which appeared in the London *Electrical Review* of Dec. 25, 1896, of his article on "Electricity vs. Compressed Air," appearing in the latter journal's issue of Nov. 25, 1896.

EDW. J. WILLIS contributed an article to *Machinery* of April, 1897, describing the power house of the Richmond Traction Co., of Richmond, Va.

'90.

At a meeting of the Amer. Institute of Electrical Engineers, held in Chicago, Oct. 28, 1896, H. M. BRINCKERHOFF contributed a long and interesting discussion on the topic before the meeting: "Electric Traction under Steam Railway Conditions."

Mr. Brinckerhoff has been advanced from associate to full membership in this association.

'91.

B. W. CARLL started on a trip to Mexico and South America, about the middle of February, in the interest of the Chrome Steel Works of Brooklyn, N. Y.

JESSE A. DAVIS has been appointed to the position of Naval Steel Inspector, U. S. Gov. His temporary address is 5102 Newhall Street, Germantown, Pa

The Amer. Gas Light Jour. of March 29, 1897, contains an article by GEO. F. SUMMERS on "Street Main Bookkeeping."

'92.

In 1895 the City Council of Baltimore, Md., created an electrical commission to inquire into the question and to submit a plan for the construction of a system of conduits for the accommodation of all the overhead lines in that city except the trolley lines. NICHOLAS S. HILL, who was appointed engineer to the commission, prepared an exhaustive report upon the question, and the plans suggested in his report have been recommended for adoption by the City Council. *The Electrical Engineer* of Jan. 13, 1897, gives the method of subway construction recommended in Mr. Hill's report.

H. LOEWENHERZ is at present engaged with his father at 23 Park Row, Room 19, New York City, in the General Advertising Business.

'93.

WM. B. AXFORD is Vice-President and Chief Engineer of The Harriman Wrought Iron Company's Furnaces at Harriman, Tenn.; Offices at 76 Montgomery St., Jersey City, N. J.

W. H. H. ROBERTS is in the employ of the Johnson Temperature Regulating Co., 240 4th Ave., New York City.

R. E. CHANDLER, who is taking a post-graduate course at Sibley College, has been making tests of steel at low temperatures.

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BOOK NOTICES.

THEORY AND CALCULATION OF ALTERNATING CURRENT PHENOMENA. By Charles Proteus Steinmetz. New York: The W. J. Johnston Co. Price $2.50.

The problems involved in the calculations of alternating current circuits are by no means simple, and many of the writings on this subject have been so full of mathematics as to be unintelligible to the average reader.

Mr. Steinmetz is to be congratulated upon having produced a work which, although necessarily mathematical, is explicit and practical, and embodies the results of an extended experience. The book is not a beginner's book, but presupposes elementary knowledge; this is fortunate as it tends to keep out unnecessary matter. The author has avoided the use of the calculus; this is not in general an advantage, but may be preferable for some readers. In the analytical treatment extended use is made of complex quantities; by their use the problems of combining sinusoidal alternating waves are greatly simplified. The algebra of complex quantities is explained in a separate appendix, and no previous mathematical knowledge beyond ordinary algebra and trigonometry is necessary.

The reciprocals of impedance and reactance are termed by the author respectively admittance and susceptance; by the use of these and of complex quantities the laws for divided circuits are stated in forms similar to those for series circuits, and are therefore quite simple.

The subjects of Induction Motors, Synchronous Motors, and General Polyphase Systems, are treated in special chapters. The author also discusses at length the effects of distorted wave-shape and of higher harmonies, and reaches the conclusion that the importance of proper wave-shape is generally overrated.

On the whole it is safe to say that the work is one which every student and practitioner of the subject should possess if he wishes to familiarize himself with the latest developments of the science.

ROENTGEN RAYS, AND PHENOMENA OF THE ANODE AND CATHODE. By Edw. P. Thompson, M.E., E.E., etc., with a concluding ch pter by Prof. Wm. A. Anthony, Formerly of Cornell University, etc. D. Van Nostrand Co.

To any one desiring, in compact form, the substance of the countless publications recently made on the subject of the Roentgen rays, together with much information as to subjects closely allied to this, we can recommend the above book which is thoroughly illustrated with 60 diagrams and 45 half-tone plates.

"A PRIMER OF THE CALCULUS." By E. Sherman Gould, M. Am. Soc. C. E. D. Van Nostrand Co. Science Series.

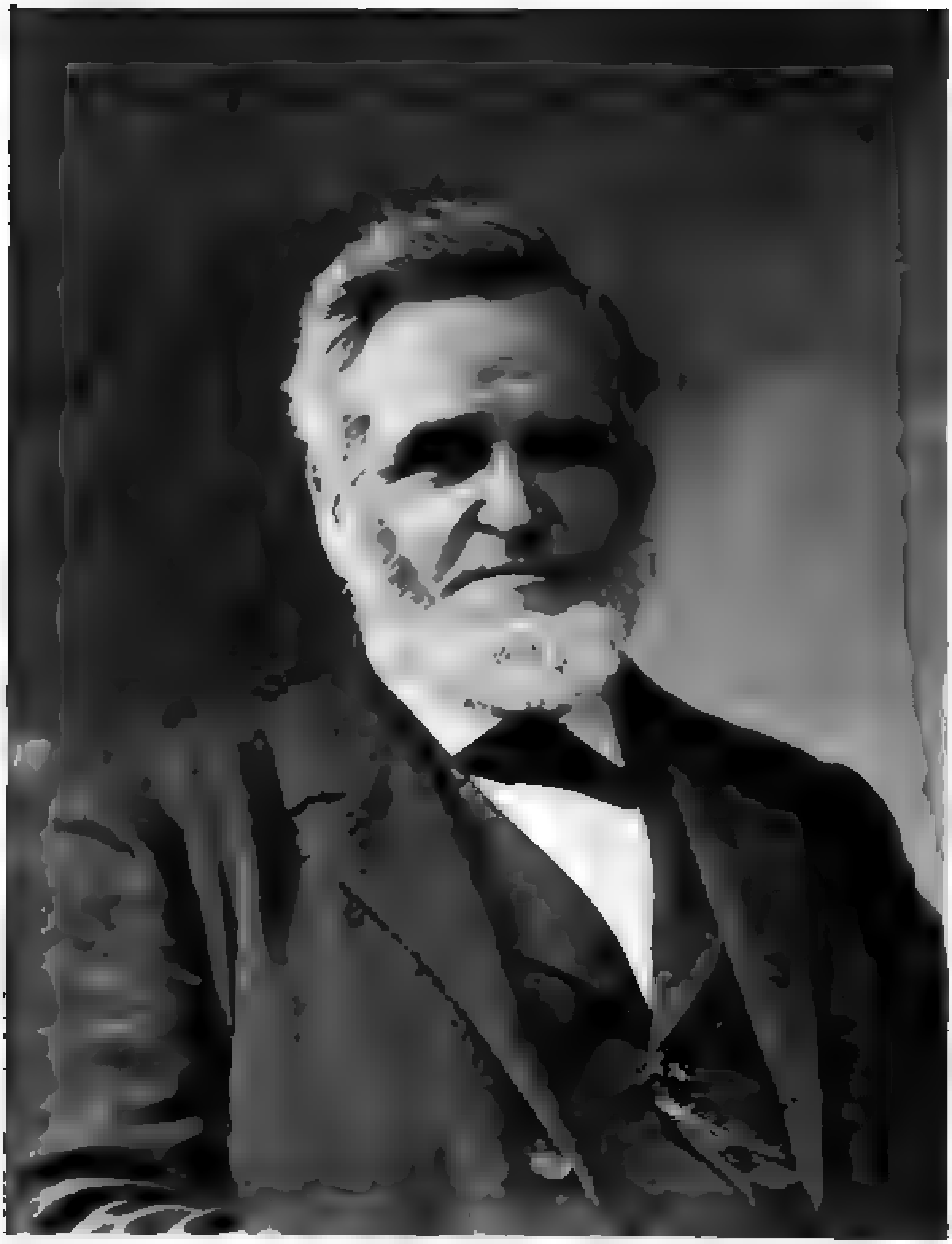
In this little work rules are developed for differentiating and integrating algebraic functions of a single variable.

Applications are then made to a few problems under each of the following headings:—

Maxima and minima, determination of lengths of plane curves, areas of plane curves, volumes of solids of revolution, to finding centre of gravity and to problems in acceleration.

The author has clearly demonstrated, without deeply discussing the theory of the Calculus, its great power and practical value as compared to previous methods, for the solution of a great variety of problems.

PROFESSIONAL



From photograph by "Pach Bros," taken March, 1897.

De Volson Wood

THE STEVENS INDICATOR.

VOL. XIV. JULY, 1897. No. 3.

OBITUARY.

DE VOLSON WOOD.

Professor Wood died suddenly on Sunday, June 27th at the age of 65 years.

It has been well known to Prof. Wood's relatives and most intimate friends that since his very severe attack of diabetes about twelve years ago he has not shown his old-time vigor or physical endurance. His recovery at that time was considered most remarkable and the large amount of scientific work he has accomplished since then, knowing full well, as he has repeatedly stated, that this dread disease, was hanging over him, is still more remarkable.

Professor Wood displayed unusual vigor in his classes and in reviewing the theses of the graduating class during the closing days of the college year. He was present at all the social gatherings during commencement week, remarking to his friends that he could not remember ever having enjoyed the various exercises more thoroughly and that his health was apparently much better than it had been for a long time.

After the commencement exercises on Thursday evening, June 17th, Prof. Wood, who lives at Boonton, N. J., repaired to the home of his brother Hudson A. Wood, 1107 Garden Street,

Hoboken to spend the night. He had been in the house but a few minutes when he was suddenly taken ill, complaining also of severe pains in the head. He so far recovered from this attack that hopes of a speedy restoration to his usual health were entertained, but the following Sunday, about noon, he suffered a relapse and died very suddenly, the immediate cause being paralysis of the heart. Until within a few moments of his death Professor Wood thought he would recover; his disposition was cheerful and his voice was strong. The end, however, of a great life was near at hand and he seemed to realize it at the last minute for with his last breath he said "I am going."

The funeral services were held at the residence of his brother Monday afternoon, after which his body was taken to Ann Arbor, Michigan, for interment in the family plot at that place.

Professor Wood left a widow, two sons and three daughters. His younger son, Arthur J., was graduated from Stevens Institute a year ago.

Professor Wood was born near Smyrna, N. Y., in 1832. At the early age of 17 he began teaching in his native town. In 1853 he was graduated from the Albany State Normal School, where he was immediately afterward appointed Assistant Professor of Mathematics. Later he attended the Rensselaer Polytechnic Institute at Troy, being graduated in 1857 with the degree of C. E.

He then started for the west, and while visiting the University of Michigan at Ann Arbor was offered the chair of Civil Engineering, which was temporarily vacant. Its incumbent, however, did not return, and Professor Wood was appointed to fill the chair, which he occupied for 15 years. During this time Professor Wood achieved an enviable reputation as a scholar, a teacher and a writer of mathematical and scientific literature. Among his students, at that time, was Mr. Brush, of electrical

fame, who has said that "Professor Wood got more genuine study out of me than any other teacher I was ever under."

In 1872 Professor Wood accepted the Professorship of the Department of Mathematics at the Stevens Institute of Technology, which position he held until 1885 when he was transferred to the Department of Mechanical Engineering. This position he held at the time of his death.

As a writer of engineering literature Professor Wood was most prolific. Nearly all the text books used by him, whether in teaching Civil Engineering, Mathematics or Mechanical Engineering, came from his pen, and in all cases his books have been widely used and have also been regarded as authorities in their respective subjects. Some of his text books are *Trusses, Bridges and Roofs*, published in 1872; *Wood's Edition of Mahan's Civil Engineering*, 1873; *Treatise on the Resistance of Materials*, 1875; *The Elements of Analytical Mechanics*, 1876; *Wood's Edition of Magnus' Lessons in Elementary Mechanics*, 1878; *Coördinate Geometry and Quaternions*, 1879; *Key and Supplement to the Elements of Mechanics*, 1884; *Key and Supplement to the Mechanics of Fluids*, 1884; *Trigonometry*, 1885; *Thermodynamics*, 1887, and enlarged, 1889; *Turbines*, 1895. Professor Wood was revising his *Thermodynamics*, with a view to uniting more closely the theory and practice on this most important subject, when death came.

Professor Wood was a heavy contributor to the various mathematical, philosophical and engineering societies to which he belonged, as well as to many of the leading engineering publications. It would be an endless task to enumerate all of these contributions; a few, however, are given to show the scope of his work:

Foundations, in "Johnson's Cyclopedia"; *Mechanics*, in "Appleton's Cyclopedia of Mechanics"; *Alligation*, in the "New York Teacher," which is highly commended in "Brook's History of Arithmetic"; *Luminiferous Ether*, in the "London Philosophical Magazine" and in "Van Nostrand's Engineering Magazine," and also "Science Series No. 85." "The Railroad Gazette" says of this article that it is "probably the best monograph in the language on this subject"; *Radiant Heat not an Exception to the*

Second Law of Thermodynamics, in the "American Engineer"; *The Mechanical Equivalent of Heat*, in the "Railroad and Engineering Journal"; *The Strength of Iron as Affected by Tensile Stress while Hot; Expansion of Timber due to Absorption of Water; Some Properties of Ammonia; Mechanical and Physical Properties of Sulphur Dioxide; Theoretical Investigation of the Efficiency of Vapor Engines*, and *Negative Specific Heat*, in the "Proceedings of the American Society of Mechanical Engineers"; *The Turbine of the Niagara Power Company* and *Flexure of an Elastic Ring*, in the STEVENS INDICATOR. In addition to the above Professor Wood contributed to the "American Mathematical Monthly," the "Michigan Journal of Education," the "Journal of the Franklin Institute," the "Railroad Gazette," the "Mining and Engineering Journal," the "National Educator," the "Mathematical Visitor," the "Analyst," the "Educational Notes and Queries," "Science," the "Annals of Mathematics," the "New England Journal of Education," the "Mathematical Magazine," the "Engineer," the "Barnes Educational Monthly," the "Mathematical Messenger," and the "American Machinist."

Professor Wood was an active member in several prominent scientific and engineering societies, among which might be mentioned the American Society of Civil Engineers; the American Association for the Advancement of Science, of which he was the Vice-President in 1885; the American Mathematical Society; the American Society of Mechanical Engineers; the Society for the Promotion of Engineering Education, of which he was the first President, and in a number of other societies he was an honorary member.

Professor Wood needs no eulogy from home quarters. His remarkable personality has stamped itself permanently on every student who has been fortunate enough to listen to his teachings. He never courted favor; he was always open, frank and honest in all his dealings with the students. The truth was bound to fall no matter where it struck. Professor Wood has said to the writer, several times, that it was not what people said of one while alive or even soon after death; but what they said ten or fifteen years after death was what one should care about. Judged by his own standard we can safely say that in the years to come

Professor Wood will grow to be more and more admired and loved by those who knew him.

His eulogy has been spread and his loss mourned throughout the length and breadth of this land and even in foreign countries, by the scientific publications, which were always eager to secure an article from his pen. From any of them we could quote kindly words for Professor Wood. Space, however, forbids a publication here of any more than one of these many tributes. The following sentiments are from the *Railroad Gazette* of July 2:

Professor Wood was a man of wide and enviable reputation. He had personal qualities which impressed themselves promptly and strongly upon those who came in contact with him, and as a consequence of all these conditions he was one of the best-known professors in the United States. But beyond all that lay extraordinary ability as a mathematician and as an analyst, remarkable strength and simplicity of character and a genius for teaching which made his reputation a good deal more than temporary or local. His powers as a mathematician, however, have given him a permanent place in the literature of engineering, and no student of the higher mathematics of engineering can remain ignorant of the name of DeVolson Wood. But his real greatness was as a teacher. In one sense perhaps that is a misfortune for a man, because he leaves no monument except in the hearts and in the minds of the men who actually came under his personal influence. His fame becomes a tradition, fading away and gradually disappearing. On the other hand, is this not the very best work that a man can do in the world—the work of a really strong and sound teacher?

It would be difficult to sum up in a few words all the qualities which made Professor Wood great as a teacher, but the fundamental quality was his own downright sincerity and his faith in his own work; his mind knew only one test, and that was the truth. To him things were either right or they were wrong, and facts were facts or they were not facts, and he saw no occasion for trying to find any middle ground. But the pursuit of the truth is often enough an arid enterprise, and a man needs more than his own sincerity to get young men to follow him eagerly in that

enterprise; and Professor Wood did get his students to work with alacrity, with eagerness, with enthusiasm. A strong element in this was his own rugged and wholesome enthusiasm; another was his air. His solid and robust figure, his keen eye and square jaw, his frank and ready smile—all these were part of his influence on the young men. The youth who came in contact with him could not help feeling that he stood before a real man, a man strong and sound, mentally and physically; and while youth is not very analytical it is impressed by a man of such quality without knowing why it is impressed. The writer of these words, who had the fortune to sit under Professor Wood four years, can testify that no other teacher ever gave him such hard lessons or ever got out of him so good recitations, and yet there was no sense of hardship in it. It seemed a natural and inevitable thing to work about five times as hard for Professor Wood as for any other teacher, and this perhaps was largely a result of his own enthusiasm in the work. He had furthermore a gift of personal interest in his students. Probably a very small percentage of his pupils—and they must have been very unworthy students at that—failed to feel that Professor Wood had a particular personal interest in them. It was not that he took any special trouble with any one man, but he was always able to carry a man's personality in his mind, and he seemed always to be interested in knowing something about a man's career. And so it came about that his influence on the lives of his students did not cease when they left his class-room.

Professor Wood was an active and sincere Christian gentleman, always interested in good work and always exerting a good influence in the community about him. Among a select body of students his name will be known and honored for generations to come as the name of a clear and able writer on the mathematics and mechanics of engineering; among a great body of teachers, students, engineers and administrators he is remembered in gratitude and love as a strong and wholesome and stimulating friend.

HISTORICAL AND DESCRIPTIVE REVIEW OF ACETYLENE.

BY EDWIN RUST DOUGLAS, M.E., '93.

Assistant in Physics at the Jefferson Physical Laboratory, Harvard University.

Metallic potassium, first obtained by Sir Humphry Davy in 1807 by the electrolysis of potash, was soon after prepared by heating together potassium of tartrate and carbon. In 1836 Edm. Davy found that, by treating with water the black mass so produced, there were given off large quantities of a gas which he called klumene.

In 1860 Berthelot decomposed, at a red heat, the vapors of various organic substances, such as ether and alcohol, and found among the products a gas which he named Acetylene. In the years following he made many investigations upon it and on its compounds,* producing it in various ways, as by direct union of carbon and hydrogen in the electric arc and as a result of incomplete combustion. He discovered a group of metallic carbides and acetylides. Berzelius showed Edm. Davy's "black mass" to be potassium carbide and his Klumene was identified as Acetylene.

In 1862 Wöhler obtained calcium carbide, afterward to assume so much importance, by fusing with carbon an alloy of zinc and calcium and, by reaction of this carbide with water, produced acetylene†. Owing to the difficulty of the process, this method was interesting only from a theoretical point of view. For many years the most convenient source of acetylene was the incomplete combustion of a jet of air in an atmosphere of illuminating gas,‡ the products being passed through an am-

* *Annales de Chemie et de Physique*, 3d series, Vol. 67, p. 52. 1863.

† *Annalen der Chemie und Pharmacie*. Vol. 124, p. 220. 1862.

‡ *Journal of the London Chemical Society*, 1866, p. 152.

moniacal solution of protochloride of copper. The resulting precipitate, acetylide of copper, after boiling to expel dissolved gases, was decomposed by hydrochloric acid, and the acetylene set free. This precipitate, being highly explosive when dry, was necessarily handled in a moist condition.

Determinations of the density, heat of formation, and heat of combustion were made by Berthelot,* from the first of which the molecular constitution was decided. The last two were redetermined by Julius Thomsen in 1872 and in 1881.†

Cailletet, in 1877, made experiments on the pressure of the saturated vapor of acetylene,‡ but, doubtless owing to impurities in the gas, he obtained results which are very much too high. More nearly correct values were found by Ansdell in 1879.§ He determined, also, the critical point of the liquid and vapor and the compressibility of the liquid at different temperatures.

About 1892 there was made nearly simultaneously by Mr. Thomas L. Willson in America and by M. Henri Moissan in France, a discovery which has given to acetylene an entirely new interest. The priority, at least of announcement, seems to belong to Mr. Willson. In experimenting, at Spray, N. C., with an electric furnace, he took occasion to heat together lime and coke, hoping that, at the high temperature, the former might be reduced. Instead of metallic calcium there resulted a black, stony mass, apparently worthless. This, by chance, coming in contact with water, there was evolved a malodorous, inflammable gas, soon found to be acetylene. The electric furnace gave the means of preparing cheaply and easily the calcium carbide discovered by Wöhler thirty years before.

* *Comptes Rendus*, [illegible]

† *Thermochemische* [illegible] Vol. II, p. [illegible], and Vol. IV, p. 72.

‡ *Comptes Rendus*, [illegible] 1877.

§ *Proceedings of the Royal Society*, Vol. 29, p. [illegible] 1879.

In the INDICATOR of October, 1894, may be found a note relative to the appearance and properties of the carbide.

Interest in this unique substance and its product was quickly aroused. Scientific investigations were begun, patents taken, and companies formed. There is now a large amount of capital invested in plants for the production of carbide, the electrical energy being, in all cases, obtained from water power.

The properties of calcium carbide and acetylene, with a review of the work lately done regarding them, are as follows:— Calcium carbide, CaC_2, when nearly pure, is a stony, gray substance of density 2.22, very hard, sometimes showing a more or less crystalline structure, infusible except under the electric arc. It has a decided odor of impure acetylene and an unctuous feel, due to liberation of gas by the moisture of the fingers. It is formed by the direct union of carbon and calcium at the high temperature of the electric furnace. Its heat of formation per gram-molecule* has been determined by M. de Forcrand† as—7250 gram-calories from C_2, diamond, or as—650 g. cal. from C_2, amorphous. The difference between these two quantities, 6600 g. cal., represents the heat absorbed by one gram-molecule of diamond in changing to amorphous carbon. The heat of formation being negative shows that under these conditions *heat is absorbed* by the union of carbon and calcium, or the compound is said to be endothermic. But it is probable that the actual formation in the electric furnace is from gaseous, not solid carbon, so there must be added the heat of volatilization of carbon, giving, as the heat of formation from solid calcium and gaseous carbon, $84200 - 7250 = +76950$ g. cals. per gram molecule.

In making these calculations M. de Forcrand made use of a value found by Berthelot for the heat of formation of acetylene.

* g. mol., the molecular weight expressed in grams; *e.g.*, 1 g. mol. of $CaC_2 = (40 + 2 \times 12)$ grams $= 64$ g.

† *Comptes Rendus*, Vol. 120, page 682. 1895.

Degrees C.	70 Atmos.	95 Atmos.	120 Atmos.	160 Atmos.
49.°	....	0.00343	0.00169	0.00078
41.	....	0.00138	0.00099	0.00076
35.	0.00171	0.00113	0.00078	0.00065
28.6	0.00122	0.00083	0.00072	0.00050
22.5	0.00079	0.00065	0.00057	0.00047
16.0	0.00066	0.00050	0.00049	0.00035
4.4	0.00047	0.00042	0.00034	0.00032
0.	0.00041	0.00036	0.00025	0.00029

These numbers represent $\frac{1}{v} \cdot \frac{dv}{dp}$ under the varying conditions.

Ansdell gives the critical temperature of the liquid and its vapor as 37°.05. This is probably somewhat in error due to impurities in the gas.

The most nearly correct values for the pressure of the saturated vapor of acetylene are those found by P. Villard,* as follows:

Temperature, C.	Pressure, Atmos.
— 90.° (solid)	0.69
— 85	1.00
— 81. (melting point)	1.25
— 70. (liquid)	2.22
— 60	3.55
— 50	5.3
— 40	7.7
— 23.8	13.2
0	26.05
+ 5.8	30.3
+ 11.5	34.8
+ 15.0	37.9
+ 20.2	42.8

The curve on the following page (Fig. 1) is plotted from these.

Under low pressure acetylene burns in free air with a bright but smoky flame. With greater pressure, or by any means which increases the supply of oxygen, the carbon is entirely

* *Comptes Rendus.* Vol. 120, p. 1262. June 10, 1895.

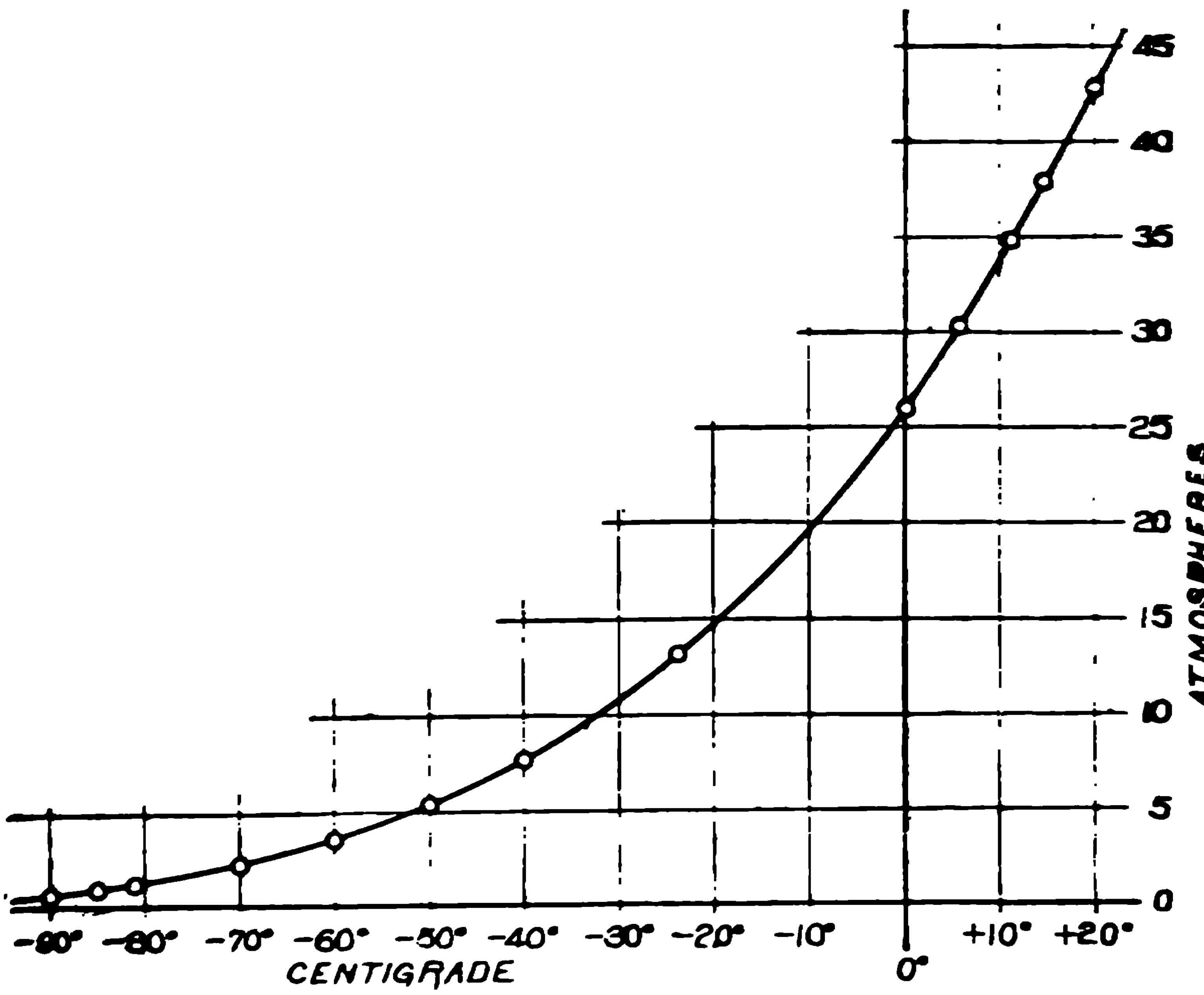


FIG. 1.

consumed and the flame becomes exceedingly bright and hot, the products of combustion then being carbon dioxide and water. It is principally this intense luminosity which has brought acetylene so rapidly into prominence. Photometrically, it is found to be fifteen or twenty times that of ordinary illuminating gas. The spectrum of the acetylene flame is especially rich in violet and ultra-violet, but weak in orange, in marked contrast to sunlight. It is probable that this property will be found to unfit it for use as an ordinary illuminant, as the effect on the eyes of an excess of violet rays is injurious. But for this very reason it is especially adapted to many purposes which ordinary illuminants only partially serve. These applications will be discussed farther on.

The heats of formation and of combustion were investigated by Berthelot and also by Julius Thomsen, but their results, as already stated, are not in complete agreement. The former found

for the heat of formation — 58,000 g. cal. per gram-molecule, for the heat of combustion, 321,000 g. cal. By a later experiment he found,—54,400 and 318,100. Thomsen gives as the average of his experiments — 47,770 g. cal. and 310,050 g. cal. per gram-molecule. It is seen that acetylene is emphatically an endothermic gas, and that its large heat of combustion is due to the great amount of heat absorbed in its formation.

The combustion of acetylene has been investigated by M. H. Le Chatelier.* He found that with less than 7.74% by volume of acetylene, relative to the total volume of a mixture of acetylene and air, the combustion produces only CO_2 and H_2O. 7.74% is found theoretically as the amount required for complete combustion. With an excess of acetylene the combustion is, of course, incomplete. For volumes between 7.74% and 17.37% of the whole, the products are CO_2, CO, H_2O, and H in proportions varying with the composition of the original mixture. With more than 17.37% of acetylene there result CO, H, C, and unconsumed C_2H_2. The precipitation of carbon as lamp black is very evident above 20%.

In large masses, to be inflammable, the acetylene must be between 2.8% and 93% with pure oxygen, or between 2.8% and 65% with air. In tubes, these limits contract as the diameter decreases. The following table gives Le Chatelier's results using air.

Diameter of tubes mm.	Limits of Inflammability. Inferior.	Superior.
0.5	No propagation.	
0.8	7.7%	10%
2	5.	15
4	4.5	25
6	4.	40
20	3.5	55
30	3.1	62
40	2.9	64

* *Comptes Rendus.* Vol. 121, p. 1144. Dec. 30, 1895.

The velocity of propagation of the flame, in large masses, varies with the composition, as shown in Fig. 2, plotted from Le Chatelier's data. At the limiting proportions the velocities are very small, 0.1 metre per sec. and 0.05 metre per sec. respectively. At the proportion for complete combustion the velocity is about 4.7 metres per sec. The maximum is obtained with a slight excess of acetylene, at 10%, giving 6 metres per sec. At the point where free carbon begins to be separated the velocity is 2 metres

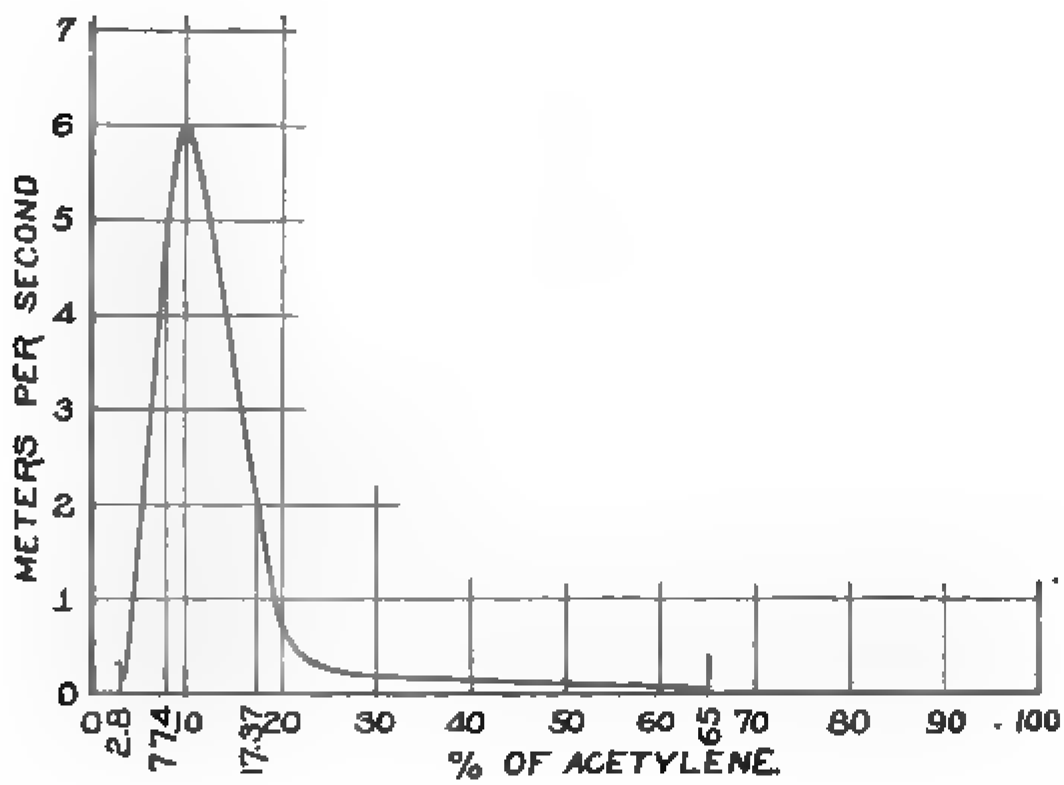


FIG. 2.

per sec. These phenomena are similar to those found for other combustible gases, except that in them the final period of very small velocities, corresponding to a separation of carbon, is absent.

The temperature of inflammation of acetylene is about 480°, much lower than in other combustible gases, in which it is generally about 600°.

M. Le Chatelier found the following temperatures of combustion :—

Mixture: 7.74% C_2H_2. Temperature, 2420°.

Reaction:

$$C_2H_2 + 2.5\ O_2 + 9.4\ N_2 = 2\ C\ O_2 + H_2O + 9.4\ N_2$$

Mixture: 12.2% C_2H_2. Temperature, 2260°.

$$C_2H_2 + 1.5\ O_2 + 5.65\ N_2 =$$

$$\frac{4}{6}(2\ CO + H_2O) + \frac{2}{6}(CO_2 + H_2) + 5.65\ N_2.$$

Mixture: 17.37% C_2H_2. Temperature, 2100°.

$$C_2H_2 + O_2 + 3.75\ N_2 = 2\ CO + H_2 + 3.75\ N_2.$$

The highest temperature ordinarily attained in combustion with air is about 2000°, less by 400° than in the case of acetylene. A flat, open flame of this gas is hot enough to melt a fine platinum wire held in it. Burned with its own volume of oxygen, acetylene gives a temperature of 4000°, or 1000° greater than that of the oxyhydrogen flame, while the products of combustion consist entirely of CO and H, powerful reducing agents. This fact may render it of great service in the laboratory or in metallurgical work.

A property common to endothermic compounds is that of decomposition, under the proper stimulus, into their components. Nitro-glycerine and the fulminates are examples of this and acetylene may be classed with them. Berthelot and Vieille have recently made extensive investigations on the explosive decomposition of acetylene due to a disturbing cause, such as shock or heat, at one of its points.* For pressures under two atmospheres the decomposition so produced does not extend to any notable distance from the centre of disturbance. For higher pressures the case is very different. The experimenters give the following table (p. 258) for decomposition, under higher pressures, by an incandescent wire.

It is seen that for an initial pressure only half that of the saturated vapor of acetylene at ordinary temperature, 20°, the explosion decuples the initial pressure. The speed of the reac-

* *Comptes Rendus*, Vol. 123, p. 523. Oct. 5, 1896.

tion is very much less than that of the explosion in the oxyhydric mixture, as previously found by them.

Absolute initial pressure. Kilog. per sq. cm.	Pressure observed immediately after the reaction. Kilog. per sq. cm.	Duration of reaction, in thousandths of a second.	Ratio of final to initial pressures.
2.23	8.77	....	3.93
2.23	10.73	....	4.81
3.50	18.58	76.8	5.31
3.43	19.33	76.8	5.63
5.98	41.73	66.7	6.98
5.98	43.43	66.7	7.26
5.98	41.53	45.9	6.94
11.23	92.73	26.1	8.24
11.23	91.73	39.2	8.00
21.13	213. 7	16.4	10.13
21.13	212. 6	18.2	10.13

The decomposition is according to the formula,

$$C_2H_2 = C_2 + H_2$$

and if, after cooling, the flask be opened, it is found to contain a volume of hydrogen equal, at the same pressure, to the volume of acetylene originally present, and also a mass of pulverulent carbon.

The temperature produced by explosion at constant volume is given as 2750°.

The decomposition of liquid acetylene is very much more powerful than that of the gas. In a flask of 48.96 c.c. capacity there was placed 18 g. of liquid. M. Berthelot remarks that, on ignition by an incandescent wire, "there is obtained the considerable pressure of 5564 kilograms per square centimetre," or 5383 atmospheres. The explosive force of liquid acetylene is, then, about the same as that of gun-cotton.

The effects of shock were studied in various ways. A one litre flask, containing sometimes gaseous and sometimes liquid acetylene, repeatedly withstood a fall from a height of six metres onto a steel anvil. The same flask, charged to 10 atmospheres with gaseous acetylene gave no explosion or inflammation when

crushed under a hammer. With liquid acetylene no decomposition ensued but the escaping gas was ignited by sparks from the flying pieces and burned explosively. This was known to be so since no trace of deposited carbon was found. Similar phenomena have been observed in the case of compressed hydrogen, where explosive decomposition is out of the question.

A flask charged to ten atmospheres with gaseous acetylene withstood, without explosion, the shock of a bullet moving with sufficient velocity to penetrate one wall and indent the other. Finally, a morsel of fulminate of mercury was detonated in a flask of liquid. The flask was torn into small pieces and a heavy deposit of carbon left over all, showing that decomposition had taken place.

The conclusion from these experiments is that compressed gaseous acetylene may be safely handled in cylinders under the same precautions as may other compressed gases. Liquefied acetylene is, under the same conditions, a source of danger. MM. Berthelot and Vieille also point out that an undue rise in temperature may cause an explosion. Such rise may occur in acetylene generators from lack of water, when the carbide may absorb water from the moist gas and points of it be raised even to incandescence. Generators should, then, be kept in continuous action under low pressure until the carbide is used up, the resulting gas being stored in holders. Again, if the gas be compressed too rapidly or with insufficiency of cooling, or if the compressed gas be suddenly admitted to any small receptacle, a disastrous rise in temperature may occur.

The specific heats of acetylene have not been determined, but their ratio, $\frac{C\,p}{C\,v}$, has been found by Manouvrier and Fournier * to be 1.273; quite different from the ratio in the case of air but nearer that for CO_2 (1.29) and for N_2O (1.27).

The coefficient of solubility of acetylene in water was found

* *Comptes Rendus*, Jan. 25, 1897, p. 183.

by Villard * to be 1.6 at 0° and for a pressure of 4.65 atmospheres. That is, under these conditions, water dissolves 1.6 times its volume of gas. If the gas be not too dense or too near liquefaction this coefficient is invariable as regards the pressure and temperature.

This large coefficient, 1.6, would make necessary the employment of some other liquid than water as a seal in gas holders intended for acetylene, as, by diffusion through the seal, a large amount of gas might be lost and an explosive mixture formed with the air near the holder. But it has been found that the addition of salt to the water practically removes the difficulty, as the solubility of the gas in salt water is very small.

Acetylene is soluble, also, in other liquids, as alcohol and acetic acid, and still more so in acetal, methylal, acetate of ethyl, and acetone. It has been proposed by MM. Claude and Hess † to utilize this property of the last named liquid as a means of storing the gas. MM. Berthelot and Vieille have also made some interesting researches on this subject and with regard to the explosive qualities of the solution. ‡ As a result of all these investigations the following facts may be stated :—

Acetone dissolves about 25 times its volume of acetylene at the temperature of 15°. Thus, at that temperature, one litre of acetone will dissolve about 26 grams of acetylene for each atmosphere of pressure. As the temperature increases this factor becomes less.

The dissolving of acetylene in acetone, under pressure, is attended, at 15°, by an increase in the volume of the solution of about $\frac{1}{25}$ for each atmosphere increase in pressure. The coefficient of expansion of the solution by heat is less than that of liquid acetylene.

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* *Comptes Rendus*, June 10, 1895, p. 1262.

† *Comptes Rendus*. Vol. 124, p. 626, March, 1897.

‡ *Comptes Rendus*. Vol. 124, p. 988, May 10, 1897.

With regard to its explosive decomposition, acetylene dissolved in acetone under pressures less than ten atmospheres is found to be entirely removed from liability to explosion. Decomposition may be set up at one point, but will not spread throughout the mass. Under these conditions, the maximum pressure produced is found to be less than one-tenth as great as that corresponding to the decomposition of all the acetylene in the containing vessel.

The gaseous atmosphere above the solution is, however, under the same risk as if the solution were not present, but, according to previous observations, for initial pressures of less than 10 atmospheres, it will not produce final pressures greater than 90 atmospheres. These facts are borne out by the following table of results:—

Cylindrical bomb of 50 cc. capacity, 22 mm. diameter, 120 mm. long.
Pressure of saturation, 10 kg. per sq. cm.

Ratio of volume of acetone to capacity of bomb.	Pressures observed. kg. per sq. cm.	Remarks.
0.56	88.1 89.5	Inflammation in the gaseous atmosphere.
	142.4 123.0	Inflammation at surface of the acetone.
	155.4 141.0	Inflammation in the acetone.
0.33	95.0	Inflammation in gaseous atmosphere.
	117.4 106.9	Inflammation at surface of acetone.
	115.0	Inflammation in the acetone.
Pressure of saturation, 20 kg. per sq. cm.		
0.33	303 558	Inflammation in gaseous atmosphere.
	>2000	Inflammation in acetone.
	>2000 5100	Inflammation at surface of acetone.

If the initial pressure be raised greatly above 10 atmospheres, the dissolved acetylene as well as the gaseous atmosphere becomes liable to explosion, and the curious result is obtained that, when this takes place, not only the acetylene, but the acetone as well, is decomposed. In the above experiment, after cooling,

the bomb was found to contain a compact mass of carbon with gaseous products consisting of hydrogen, carbon monoxide, and carbon dioxide, the necessary oxygen having come from the acetone itself and from traces of dissolved water. The pressure was over 5000 atmospheres.

An experiment was made with a flask of 13.5 litres capacity, previously tested to 250 atmospheres; such as is used to contain liquid carbonic acid. This received 7 litres of acetone which was then saturated with acetylene at a pressure of about 8 atmospheres. On ignition by an incandescent wire, the upper part of the flask became hot to the hand while the bottom remained cool, showing that only the gaseous acetylene had decomposed. The pressure rose to 150 atmospheres. The flask was not injured and the acetylene remaining was afterwards used for experiments on lighting. When opened, there was found to be suspended in the acetone a mass of pulverulent carbon apparently amounting to several litres.

In the use of solutions of acetylene it must be remembered that the pressure increases very rapidly with the temperature. Thus, in a flask of 824 cc., containing 311 g. (376 cc.) of acetone and 69 g. of acetylene, the following pressures and temperatures were observed:

Temperature, C.	Pressure, Atmospheres.
7°.8	5.42
14.0	6.52
26.3	8.42
35.7	10.21
50.1	13.50
59.6	15.77
74.5	19.86

A solution of acetylene which, at ordinary temperatures, would not be explosive, might become so by the rise of pressure due to the heat of the sun; so that the limit of ten atmospheres is one which must not be passed *at the highest temperature to which*

the solution is likely to be exposed. Of course, this depends entirely on the situation and manner of use, but probably a pressure of saturation of not more than seven atmospheres, at a temperature of 15°, will be found safe in practice.

Under such conditions, a flask of 1 litre capacity, containing 0.7 litre of acetone, would receive, safely, 127 g. of acetylene. The same flask, if charged to 10 atmospheres with pure acetylene, would contain only 11 grams. The pressure produced by an explosion of the gaseous acetylene, at 35°, would be about the same in both, but the chances of such taking place, and the probable disaster should the flask rupture, would be vastly greater with the pure acetylene.

It is readily seen that the energy required to compress a given weight of gas, and therefore the amount of water required for cooling, will be much less where acetone is used. The method by solution, then, seems to offer a practical means for the storage and transportation of acetylene.

The physiological action of acetylene has been thoroughly investigated.* The results are concurrent in stating that it is much less poisonous than ordinary illuminating gas, although in large quantities it is dangerous. The following experiments by Grehaut will serve as examples. He used mixtures of oxygen, nitrogen, and acetylene containing always 20.8% of the first, as does atmospheric air. He thus measured the specific toxicity of the gas.

A mixture of this sort containing 20% of acetylene did not inconvenience a dog after 30 minutes. With 40%, the dog was violently agitated, and after some time died. With 79%, a dog was killed in 30 minutes. A mixture was then made containing 14% of illuminating gas. This was of such a composition that there was in the mixture, 1% of carbonic oxide, the only dis-

* Grehaut. *Comptes Rendus*, Vol. 121, p. 564. 1895.
Rosemann. Translation in *Progressive Age*, p. 94, March 1, 1896.

tinctly poisonous ingredient. This mixture was powerful enough to kill a dog in 15 minutes.

Acetylene is, therefore, far less poisonous than ordinary illuminating gas. Of course, if in addition to its poisonous action it diminishes the supply of oxygen, it will be more dangerous. It should be remembered that, owing to the greater density of the former, only $\frac{1}{3}$ as great a volume of acetylene as of illuminating gas will escape through an orifice under similar conditions.

The compounds of acetylene are numerous. Only a few need be be described here. Its hydrate was discovered independently by Cailletet* in 1878 and by Villard† in 1888. It may be crystallized out of solution at a high pressure and low temperature. It is heavier than water and its crystals are without action on polarized light. Villard gives the following table relative to its dissociation.‡

Temperature. Cent.	Pressure of Dissociation. Atmos.
0°	5.75
+ 4.6	9.4
7.0	12.0
9.6	16.4
15.0	33.0

At 16° the pressure of the hydrate equals that of the moist, liquefied gas: that is, at that temperature its dissociation is complete. At ordinary pressures, the dissociation is negligible at $-5.°$ The heat of combination of liquid water with acetylene gas is $-$ 15400. g. cal. per gram-molecule of hydrate.

The compounds of acetylene with certain metals are violently explosive. Copper acetylide, $C_2H_2Cu_2O$, and silver acetylide, $C_2H_2Ag_2O$, are the best known of these. They are formed by passing acetylene through ammoniacal solutions of the respective

* *Journal de Pharmacie et de Chimie*, 4th series, Vol. 27, p. 89.

† *Comptes Rendus*. Vol. 106, p. 1602, June, 1888.

‡ *Comptes Rendus*. Vol. 120, p. 1262, June, 1895.

metals, as already described. If moist, they do not explode but when dry they become very unstable and dangerous to handle.

Copper acetylide is also slowly formed by the action of the moist gas on brass or copper. Dry gas has no effect. For this reason, only iron, steel, or lead should be used in fittings intended for acetylene.

Acetylene's field of usefulness extends, principally, in four directions :—Light, Heat, Power, and Synthetic Chemistry.

Owing to the excess of violet rays, the acetylene flame seems less adapted to general illumination than to special purposes, as signaling, photography, projection, and optical physics. It has already found a reception in polariscope work* and as a standard for photometry†.

The high temperatures obtainable with acetylene and air or oxygen, surpassing those of the hydrogen flame, will doubtless find many applications in the laboratory, in metallurgical work, or in any situation where an intense heat is required.

The extremely rapid and powerful explosion of acetylene, with air, renders it unsuitable for use in gas engines as at present constructed. It may be that the solution will come in a radical departure from present types.

The outlook for acetylene on the chemical side is very bright. It was the first so-called "organic" compound to be formed directly by union of its elements.‡ It seems destined to be the gateway to an immense region in practical synthetic chemistry. With acetylene as the starting point, the chemist may proceed to oxalic acid, hydrocyanic acid, phenol, or carbolic acid, acetic acid, ethyl and methyl alcohols, aldehyde, di-iodoform, benzene, analine, picric acid, formic acid, and so on.

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* H. H. Wiley, U. S. Dept. of Agric —See *Progressive Age*, Mar. 16, 1896, p 110.

† Violle. *Comptes Rendus*, Vol. 122, Jan., 13, 1896.

Fessenden, *Proc. Amer. Inst. Elec. Eng.*, May, 1896.

‡ Berthelot, 1861, by means of the electric arc.

It has been proposed to apply acetylene to the case-hardening of steel by passing the gas over the red hot surface. It will be decomposed and the carbon absorbed by the steel.

The cost of acetylene has been the subject of varying estimates. According to a commission appointed by the *Progressive Age*,[*] and consisting of Edwin J. Houston, Arthur E. Kennelly and Leonard P. Kinnicutt, carbide may, under favorable conditions, be produced for $[illegible] per ton. The theoretical yield is 5.8 cu. ft. of gas, at 60° F. and one atmosphere, per pound of carbide. In practice, 5.5 cu. ft. may be obtained. From these data, and allowing [illegible] % for the expenses of producing and delivering the gas, it seems that acetylene could be sold for about $[illegible] per thousand feet, or ten cents per kilogram. As the luminosity of acetylene is [illegible] times, and the heating power from [illegible] to [illegible] times, that of ordinary illuminating or heating gases, there seems here to be a chance for development.

A related topic is the production from metallic carbides of other compounds than acetylene. Moissan gives the following facts:[†]

Cerium carbide, CeC_2, and Lanthanum carbide, LaC_2, decompose with water to give acetylene, a little methane and traces of liquid and solid hydrocarbons.

Yttrium carbide, YC_2, gives acetylene and a little methane.

Thorium carbide, ThC_2, gives less acetylene and more methane than any of the above.

Manganese carbide, Mn_3C, gives equal volumes of hydrogen and methane.

Uranium carbide, U_2C_3, gives methane, hydrogen, ethylene, and a great quantity of liquid and solid hydrocarbons. The latter contain about two-thirds of the carbon originally present; with 1 kg. of the carbide they amounted to 100 g., belonging

* [illegible]

† [illegible]

principally to the olefine, though somewhat to the acetylene, series.

It is impossible to say to what developments these reactions may lead. It is to be noted that, after the decomposition of a carbide, the base still remains and may be used over and over again, if so desired. This would be a fact of economic importance in the use of rarer substances.

These facts are of great interest to the geologist as suggesting the possible origin of some petroleums. It could well be that masses of carbide of such dense and refractory substances as uranium could exist in the interior of the earth and, by their decomposition, produce some of our deposits of gas, oil, or bitumen.

VELOCITY DIAGRAMS AND THEIR CONSTRUCTION.

BY PROF. C. W. MAC CORD. SC. D.

I.

It is a familiar fact that in the operation of any piece of mechanism, the parts go through a series of motions in regular order, finally returning to their original positions: after which the same series of motions is repeated, and so on indefinitely. One complete series is called a *cycle*; in completing which it frequently happens that, supposing the first or driving piece to move uniformly in one direction, the motions of other parts will vary either in velocity or direction, and often in both. And in studying the action of any mechanical movement, or in comparing the actions of different ones, it is often desirable to have a clear understanding of the law of variation, in regard to the motion of a given piece or a given point.

Now, assuming that for a given velocity of the driver, that of the point considered can be determined at any instant, or in other words in any phase of the action—then it is beyond question that a graphic representation is the best if not indeed the only means of conveying to the mind a distinct and comprehensive idea of the law according to which the motion varies in velocity and direction.

Such a representation, or "velocity diagram," is shown in Fig. 1. It consists merely of a curve whose abscisses, set off from left to right upon the line MN, represent times, and the ordinates $11'$, $22'$, etc., represent the velocities of the moving point at the instants indicated by the points 1, 2, etc.; the positive ordinates, or those above the line, indicate motion in one direction, that in the opposite direction being indicated by the negative ordinates, below the line. And a single glance at this figure

is sufficient to establish the claim above made,—it gives in an instant all the information that could be gathered from lengthy explanations and tables of figures.

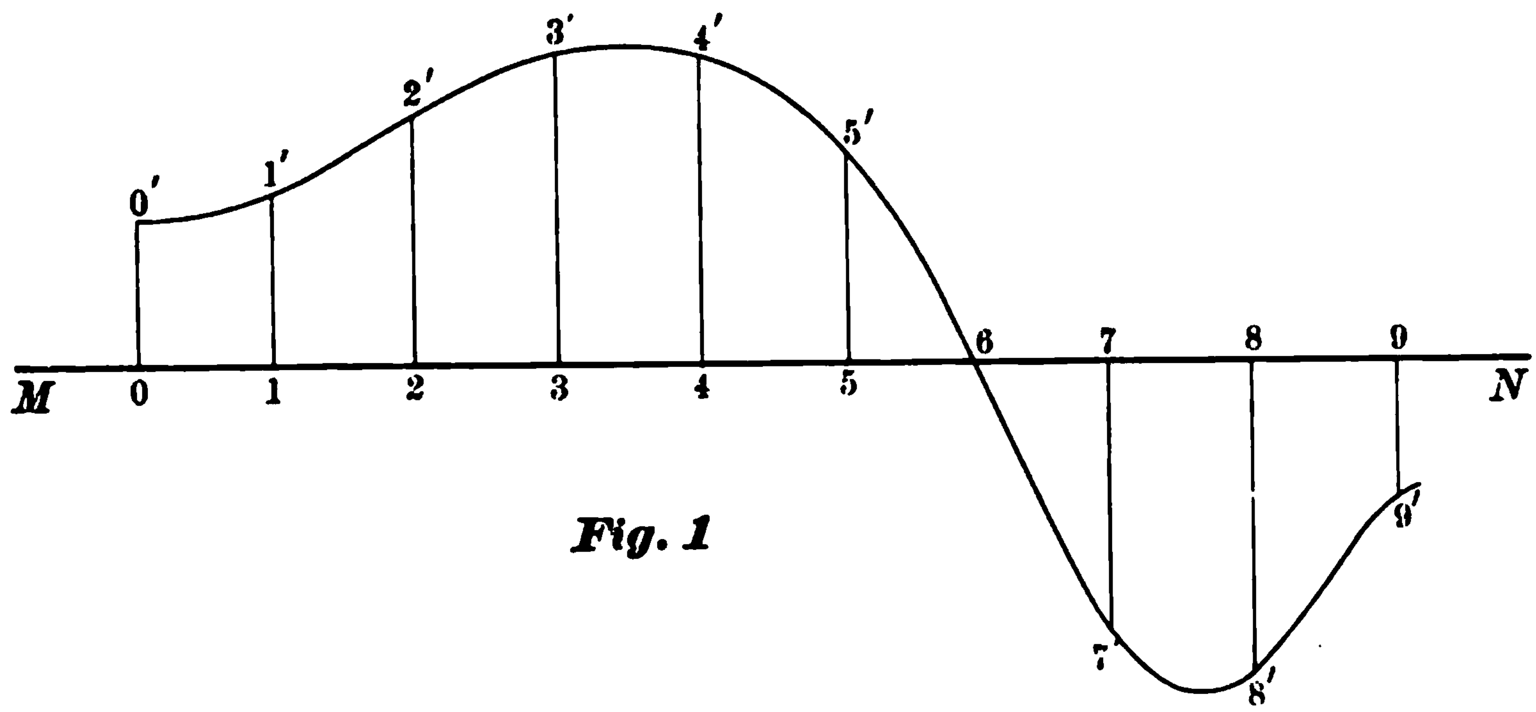


Fig. 1

Now, given the velocity of the driver, how to determine the values of these ordinates? We have here to choose between two methods of procedure, the graphic and the analytic. There is no question that the members of a train of mechanism can be represented by symbols, the laws of their motions embodied in formulæ, and the desired values ascertained by algebraic computation. In the graphic method, the motion of a point at any instant is represented in magnitude and direction by a right line of definite length; and relations may be established between lines thus representing the motions of properly selected points, and other lines closely connected with the moving pieces, such that the values sought can be determined by geometric reasoning. Of the two, the latter method is preferable for ordinary use, being far more simple and expeditious than the former, while the accuracy attainable is quite sufficient for practical purposes. Its foundations lie upon a few kinematic principles, of which we will briefly state the most important.

The first is the *composition* of motion. Suppose the point A, Fig. 2, to receive at the same instant two impulses, which sepa-

rately would impart to it the motions represented in direction and velocity by the lines AB, AC; these are called *components*, and the *resultant* of these, which is the actual direction and velocity

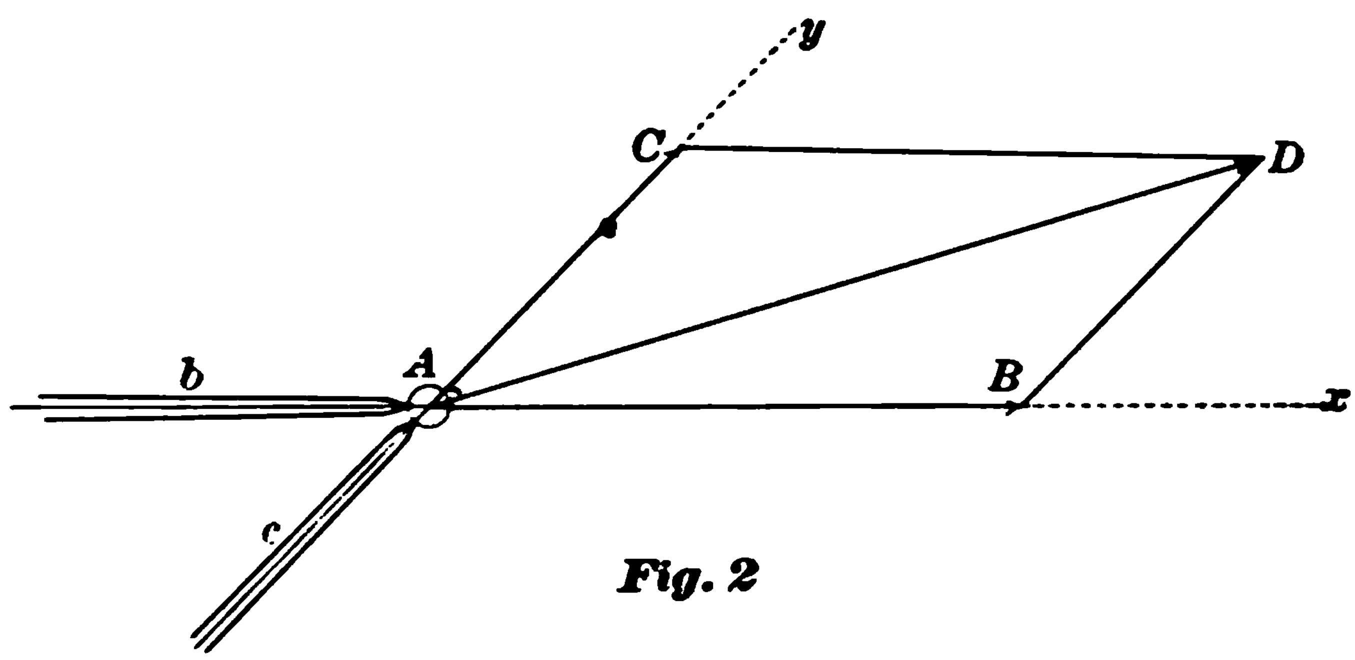


Fig. 2

of the motion of the point, is AD the diagonal of the parallelogram $ABCD$. The condition of things here is, that A is a free point in space,—as if, by way of illustration, it were a billiard ball impelled by the simultaneous strokes of two cues b and c, which are not connected with each other or with the ball; a consideration which, as will subsequently appear, is of no small importance. There may be more than two components; in that case, find the resultant of any two of them, compound that with any one of the others, and so on to the end. If there be three components not in the same plane, these will be three adjacent edges of a parallelopipedon, and the resultant will be the body diagonal which passes through the moving point: our attention however will be chiefly confined to motions in one plane, or what is practically the same thing, in parallel planes.

The *resolution* of motion is the exact converse of the preceding. If a motion can be determined by compounding two others, that motion, if given, can be separated or *resolved* into its original components. Thus, in Fig. 2, suppose the motion AD to be assigned, and let it be required to determine two components having the directions Ax, Ay; of which AD shall be the

resultant. By drawing through D, lines parallel to Ax and Ay, it is evident that we shall limit the required components, AC, AB. But AD may be the diagonal of any one of an infinite number of parallelograms; whence it follows that a given motion may be resolved into two components respectively parallel to any two lines having different directions.

Side Component and *Longitudinal Component.*—In Fig. 3, let the point A, of the right line MA, have a motion represented by AD. Resolve this into the components AC, perpendicular to MA, and AB in the direction of that line: then AC is called the side component, and AB the longitudinal component. And these components always exist, no matter how the motion AD may be resolved. Thus, if it be resolved into AC', AB'; then AC' itself has a component Ab along MA, and Ab is equal to $B'B$, so that the total longitudinal component is $AB'+Ab$, $=AB$.

Again, in Fig. 4, let AD be resolved into AE, AF;

Fig. 3

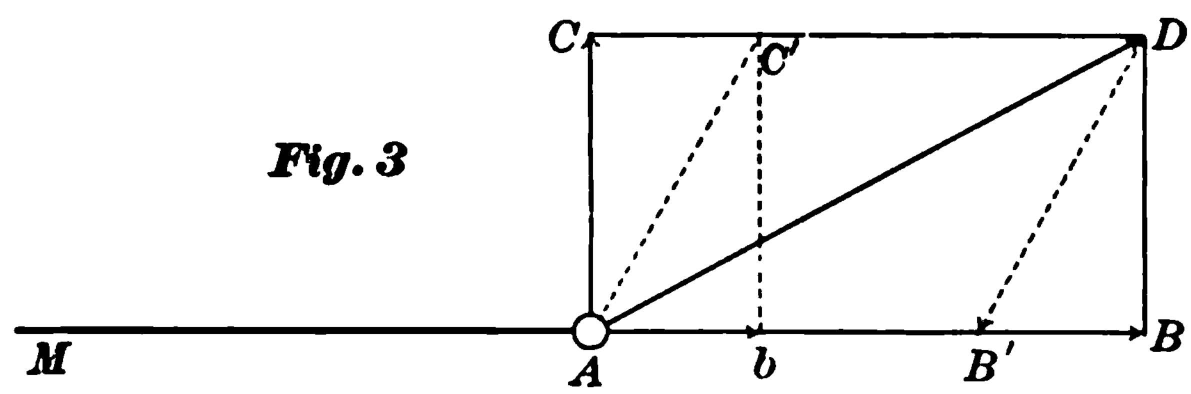
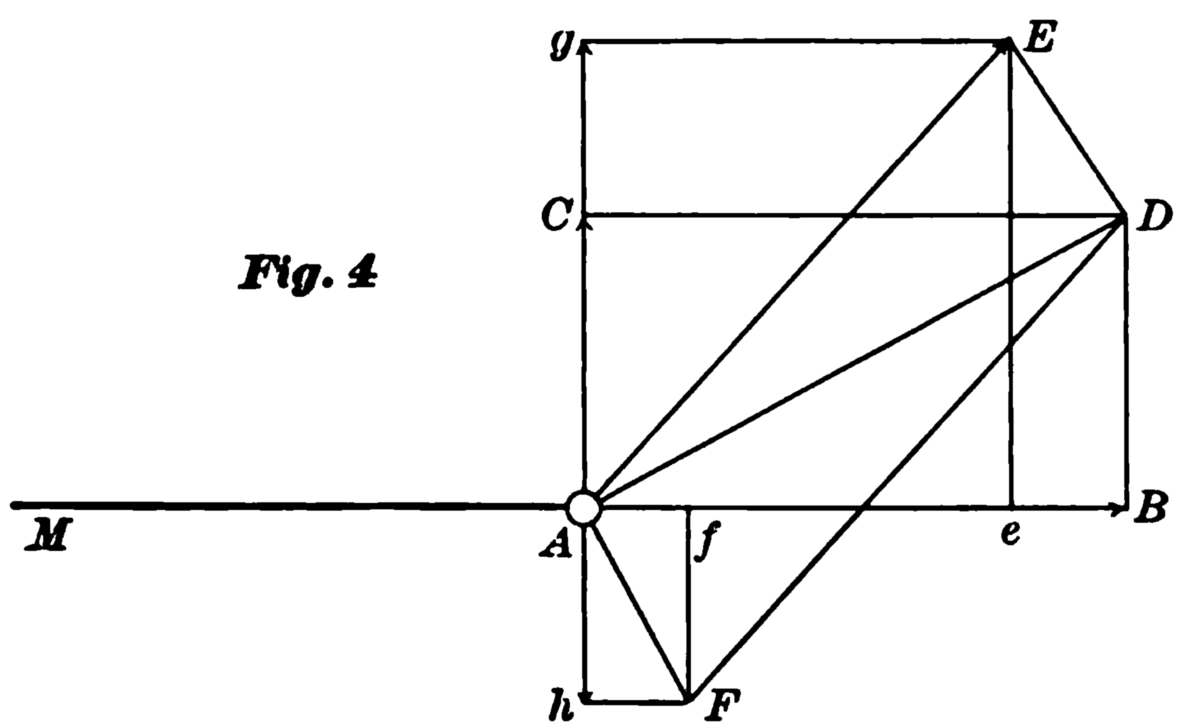


Fig. 4



then AE can be resolved into the rectangular components Ae, Ag, and AF into the pair Af, Ah: also $Af = eB$, and $Ah = Cg$: Ae and Af lie in the same direction, and the total longitudinal component is $Af - Ae = AB$: but since Ag and Ah lie in opposite directions, the actual side component is $Ag - Ah = AC$ as before.

In Fig. 5, let AM represent a rigid and inextensible line—as a piece of stiff steel wire, and let the point A have a motion AD, of which AF and AE are the side and longitudinal components respectively. Then any other point, B, of this wire, must of necessity have a longitudinal component BG, equal to AE, and in the same direction. And whatever the actual motion of the point, it follows from the preceding that the other component

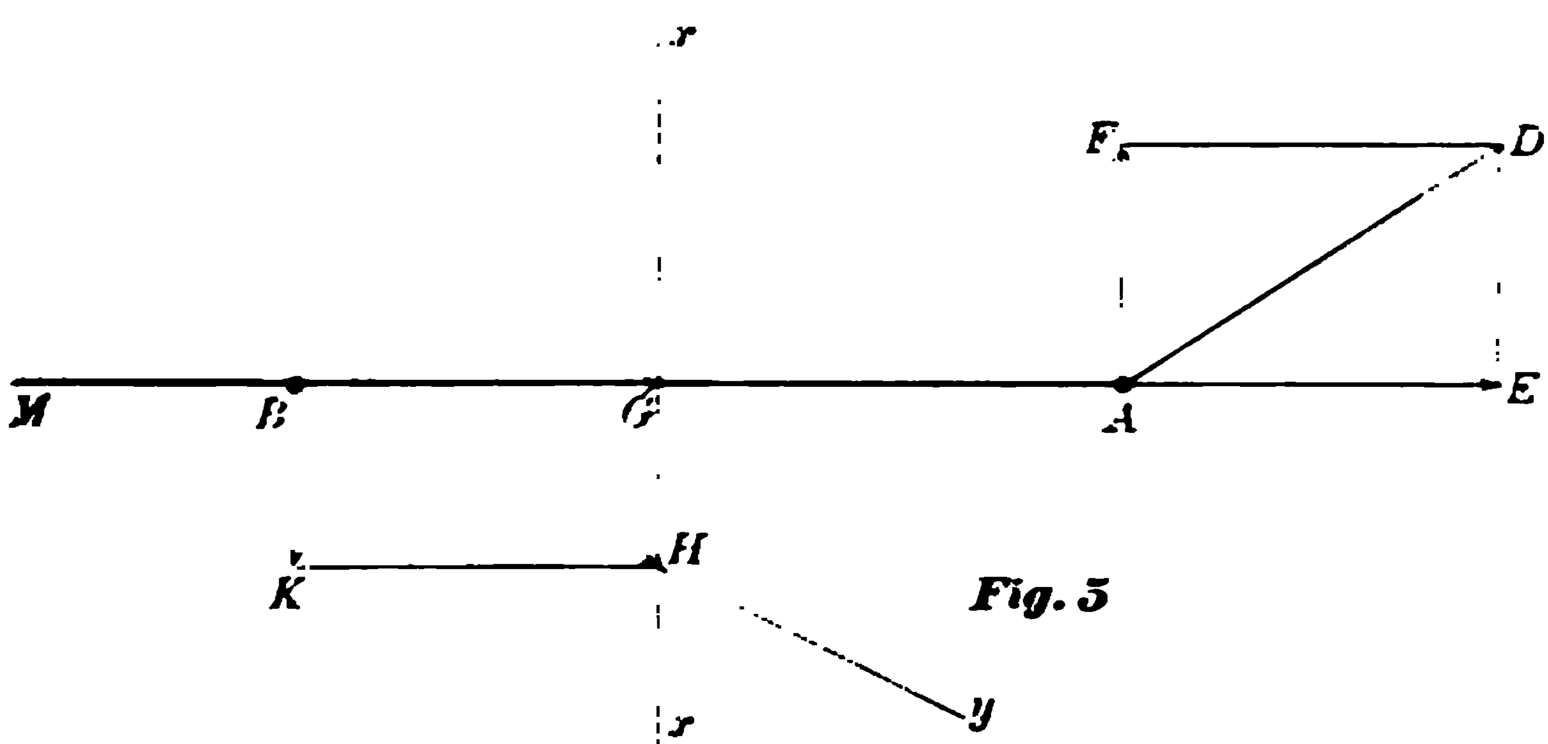


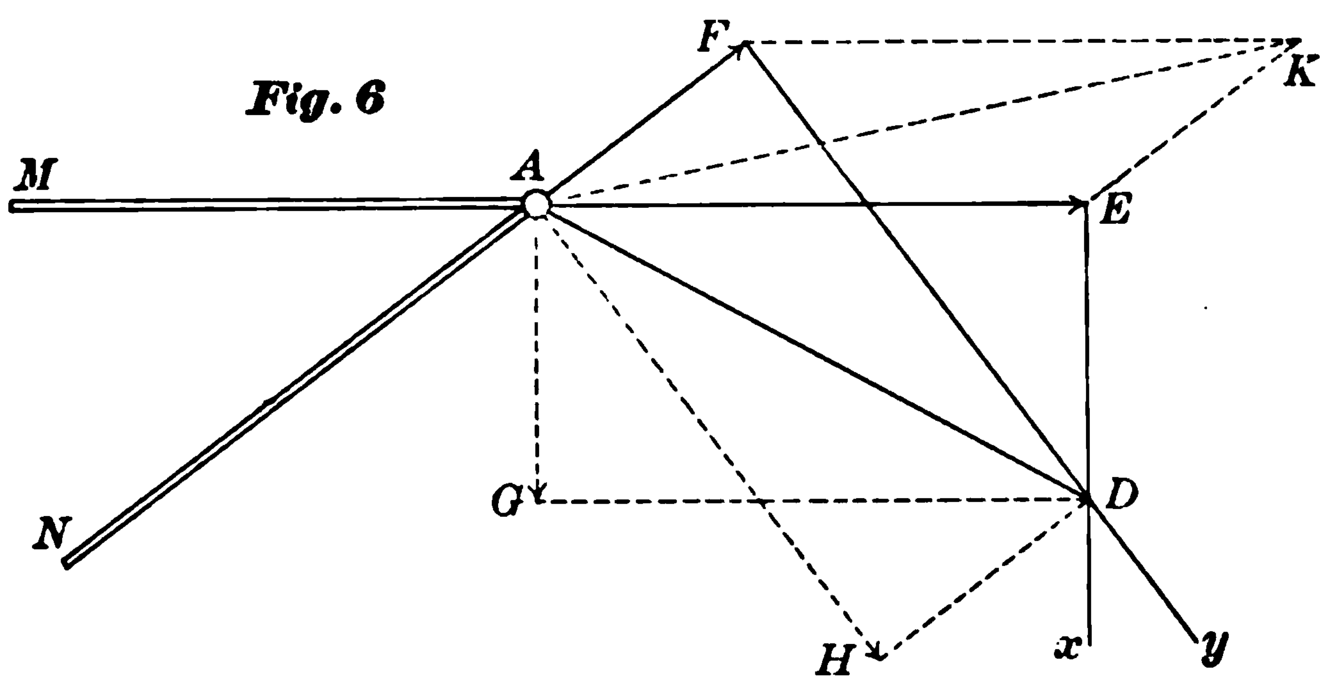
Fig. 5

must be perpendicular to AM, so that the extremity of the resultant must lie in the indefinite vertical line xx drawn through G. If then the direction By is assigned, the intersection H, of xx and By will determine BH.

In Fig. 6, AM, AN, represent two rigid bars, pivoted together at A; let AE, AF, be the absolute longitudinal components, from which it is required to find the motion of A. From what has just been shown, the extremity of the resultant must lie in Ex perpendicular to AM, and also in Fy perpendicular to

AN; it must, then, be their point of intersection *D*. Which is obviously as it should be, since the resultant *AD* thus determined can be resolved either into the rectangular components *AE*, *AG*, or into the pair *AF*, *AH*. Had we proceeded as in Fig. 1, by completing the parallelogram of which *AE*, *AF* are the sides (as one not familiar with the previous reasoning would be very likely to do), the diagonal *AK* would have neither the right magnitude nor the right direction, unless *AM* and *AN*

Fig. 6



were perpendicular to each other: and, as will be seen subsequently, there are other cases than this, in which that procedure will give erroneous results.

Effect of Side Components.—In Fig. 7, let *MN* be an inflexible steel rod, upon which the perforated balls *A*, *B*, *C*., are free to slide; then the centres of these balls are points *upon* the right line *MN*, but not *of* it, and whatever their motions may be, the longitudinal components, *AH*, *BL*, *CR*, do not affect the line, nor do they have any relation to each other, and they need not have either the same magnitude or the same direction. But obviously the side components do affect the line,—if any two of them are equal, and lie on the same side of *MN*, the whole line must be translated bodily in the direction of those two, and the side components of all its points must be equal. But if motions be assigned to any two of these balls, such that their side com-

ponents either lie upon opposite sides of MN or are unequal if they lie on the same side, then these two side components will establish a rotation of the line about some point of the line itself. If for example we give to A and B the motions AD and BE; their side components are AG and BK respectively, and drawing GK, it is perceived that MN must turn about the point O, where GK cuts it. Moreover, this latter line determines the directions and the values of the side components of the motions of all other

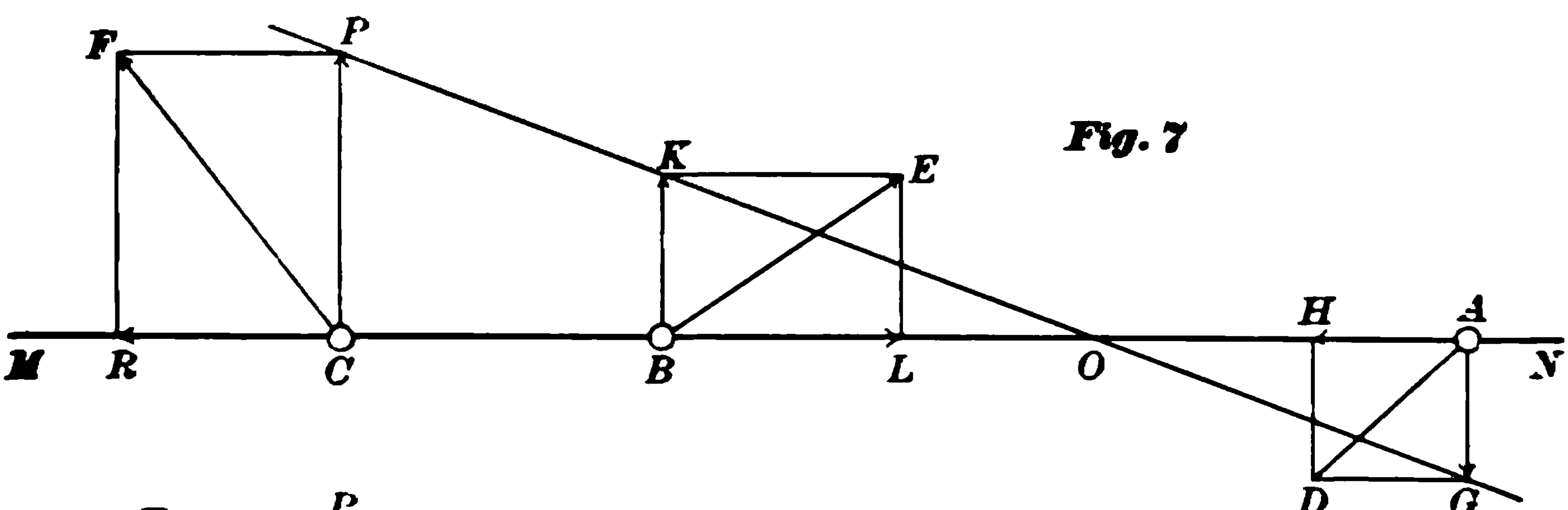


Fig. 7

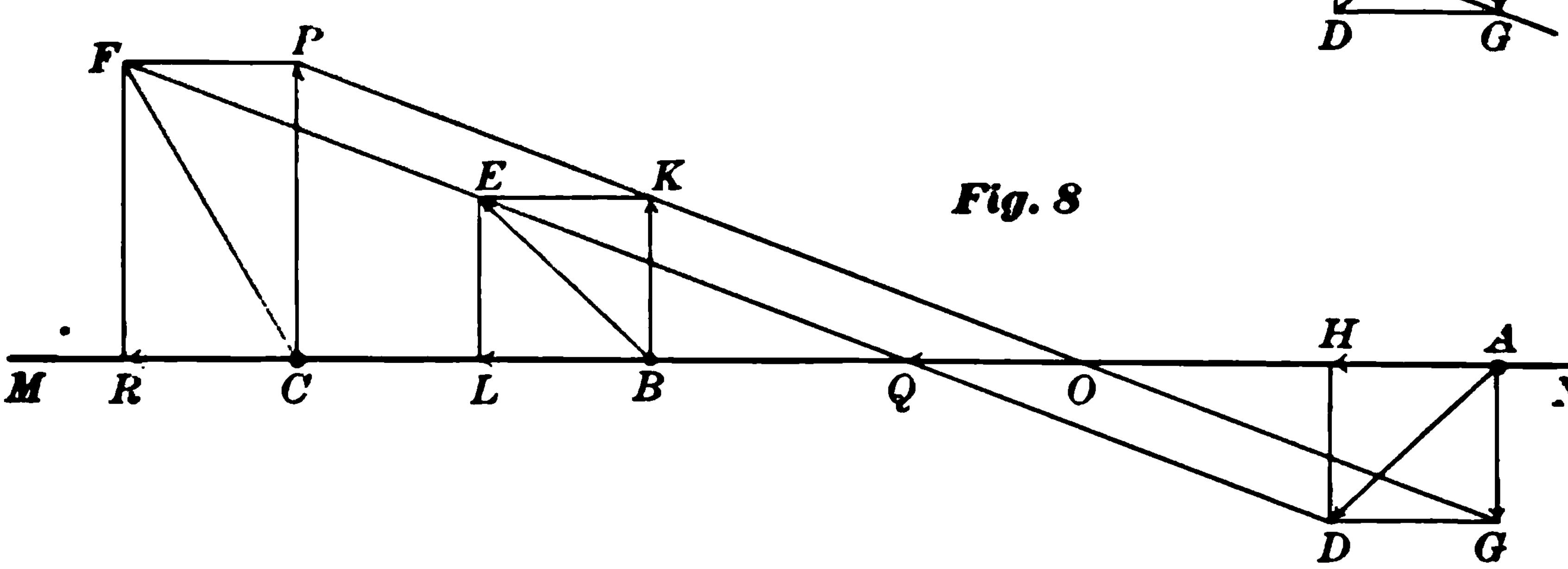


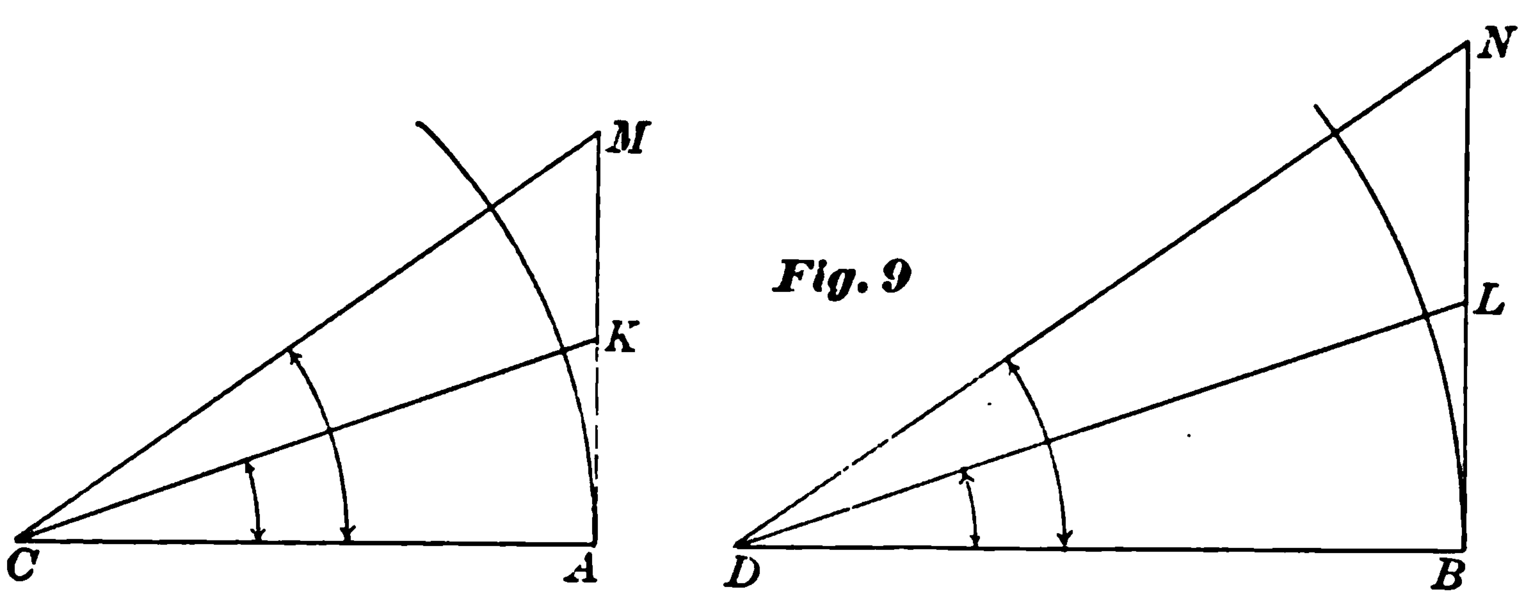
Fig. 8

points of MN; thus any point C, to the left of O, must move upward, and that at a rate CP limited by the prolongation of GK: any point to the right of O must move downward in like manner, while if a ball were placed at O, it could not move sidewise at all, though it might move endwise in either direction and with any velocity.

Now if as in Fig. 8, we consider A, B, C, to be points *of* the inflexible and inextensible line MN, and therefore as remaining always at fixed distances from each other; it is still true

that the side components AG, BK, of the simultaneous motions of two points, A and B, for example, determine the rotation of MN about O. But supposing AD to be assigned, the motion of B, for instance, would no longer be entirely arbitrary, since the longitudinal component BL must be equal to AH and in the same direction. This is also true of every point of MN, including O, whose absolute motion must therefore be $OQ, = AH$. Consequently in this case, since GD, OQ, KE, PF, are all equal, and all parallel to MN, the line $DQEF$, joining the extremities of the resultants, will be equal and parallel to $GOKP$, joining the extremities of the side components.

Representation of Angular Velocity.—The linear velocity of a point at unit distance from a centre about which the point travels



in a circular arc, is the measure of the *angular velocity* of the point about that centre. From which it follows, that whatever the distance of the point from the centre, we shall always have the value, ang. vel $= \dfrac{\text{lin. vel.}}{\text{radius.}}$

If then as in Fig. 9 the point A, revolving about the centre C, has the linear velocity AK, the angle ACK represents the angular velocity; if it be desired to find the linear velocity of B in rotating with the same angular velocity about D, we have only to make the angle BDL equal to ACK. If the angular velocity of B is to be made twice that of A, however, it is to be noted

that this is not done by doubling this angle; but we make $AM = 2\,AK$ and then make the angle BDN = angle ACM.

Instantaneous Axis of Rotation.—In Fig. 10, let AB represent an inflexible rod, and first let the points A and B move with the velocities AF, BK in opposite directions perpendicular to AB; these establish a rotation of the rod about the point O, determined by drawing FK. If we now add a longitudinal component to the motion of each point, as $AE = OG = BC$, the resultant

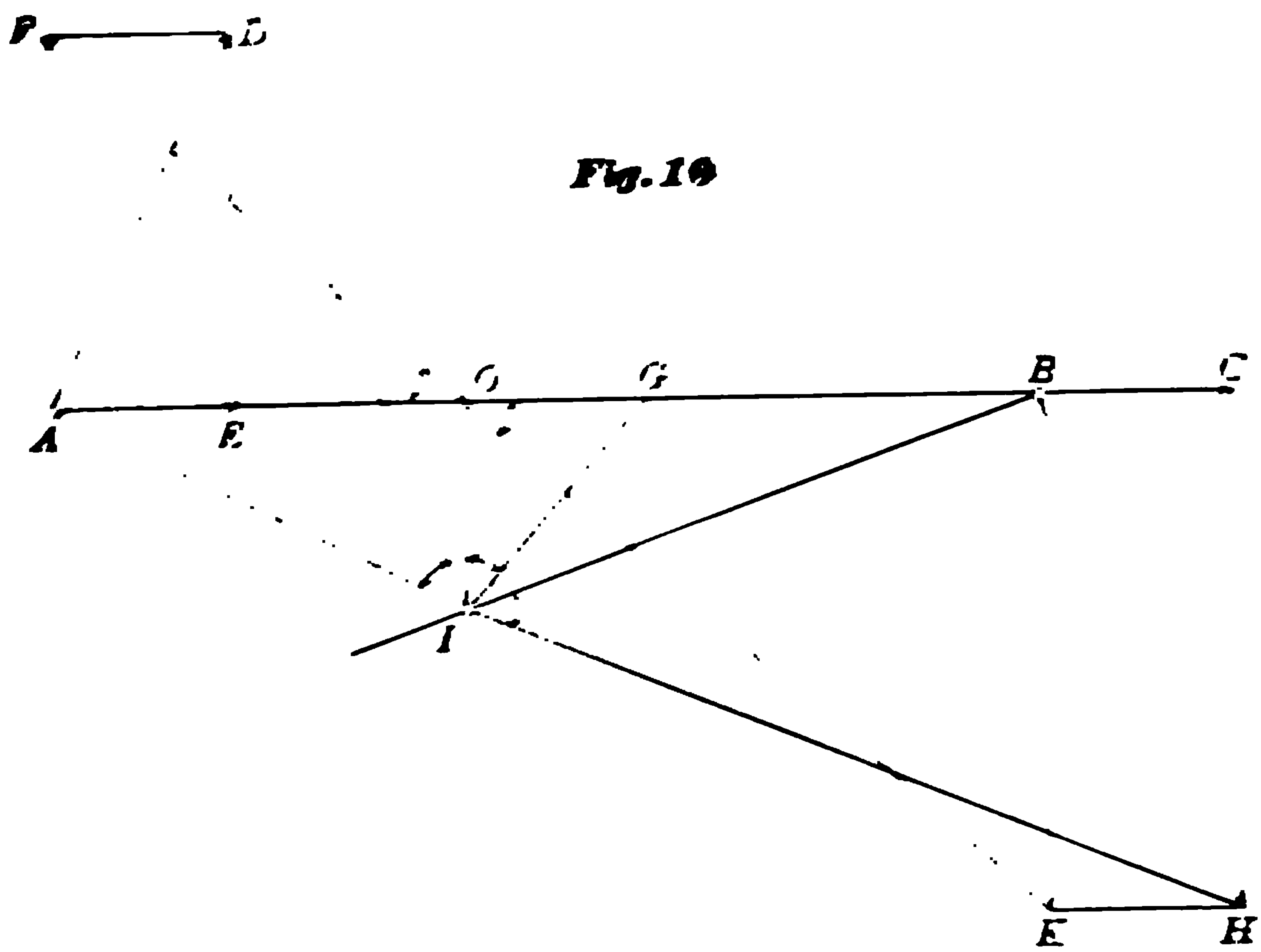


Fig. 10

motions of A and B will become AD and BH, and that of O will be OG. Draw through A and O, lines respectively perpendicular to AD and AB, intersecting in I, and draw ID, IG. The triangles ADF, AOI, are similar, whence $\frac{FA}{AO} = \frac{AD}{AI} = \frac{FD \text{ or } OG}{OI}$. Therefore the angles AID, OIG, are equal: that is to say, the two points A and O are rotating with the same angular velocity and in the same direction about the centre I: the

same must therefore be true of every other point of the rigid bar AB — and indeed it can be otherwise shown that IB is perpendicular to BH, and that the angles BIH, AID, are equal.

With reference to the bar AB, the point I is called the instantaneous axis, because during the motion of the bar, it changes its position from instant to instant, not only in space but relatively to the bar itself; and it is found, when the simultaneous motions of two points of the bar are given, as for example

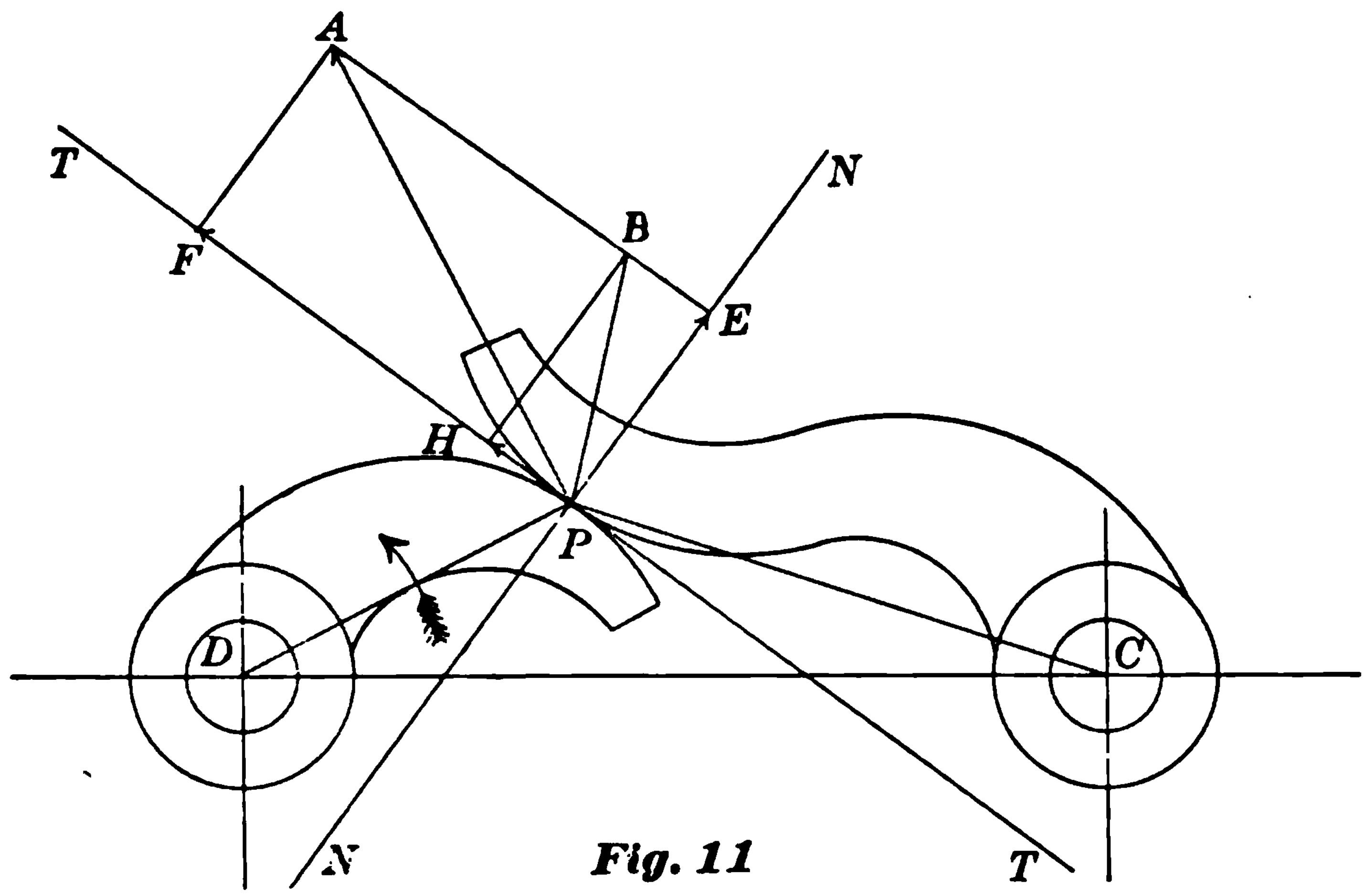


Fig. 11

AD, BH, by drawing through each point a line perpendicular to the direction of its motion.

Contact Motions—Normal and Tangential Components.—In Fig. 11 are shown two pieces turning about the fixed centres C and D, and in contact at P; if the left-hand one turn as shown by the arrow, it will push the other out of its way and compel it to turn, in this case in the opposite direction. Draw the contact radii PC and PD; also draw through P, TT the common tangent to the two curves, and NN their common normal. The point P of the driver must move in a direction perpendicular to PD; let its linear velocity be represented by PA, which can be resolved into the normal componant PE and the tangential component PF.

Of these two, the latter is obviously non-effective: it represents merely the sliding of P along the tangent, and has no tendency to move the follower. The motion of the point P of the right-hand piece must be perpendicular to PC, and must have a velocity such that its normal component shall also be PE:—consequently the extremity B of this resultant must lie in the line AE. The component PH also represents sliding along the tangent: it is clear therefore that in this case the actual sliding of one piece upon the other will be $PF - PH$, or HF.

(To be continued.)

THE ACTION OF NITRIC ACID UPON ALUMINIUM AND THE FORMATION OF ALUMINIUM NITRATE.

BY THOMAS B. STILLMAN, PH.D., M.SC.

The bibliography of Aluminium, in reference to the action of nitric acid upon the metal, is well worthy of investigation.

The statements are so conflicting, even in the recent literature bearing upon this subject, that direct experimentation was required to demonstrate the solubility of aluminium in nitric acid.

WÖHLER[1] states: "Aluminium is not attacked by HNO^3 + Aq. even when concentrated and boiling."[2]

DEVILLE[3] gives as the result of his experiments that aluminium is not attacked by boiling HNO_3 + Aq., dilute or concentrated.

RICHARDS,[4] refers to the statement of Deville but also adds—"In boiling acid solution takes place, but with such slowness that I had to give up this mode of dissolving the metal in my analysis." "By cooling the solution all action ceases."

BUFF and HEEREN,[5] coincide with Deville, "Aluminium wird weder von verd. noch konz HNO_3 angegriffen."

MONTEMARTIN,[6] "Aluminium is slowly soluble in 27 per cent. HNO_3 + Aq. 100 c.c. HNO_3 + Aq. requiring 2 months to dissolve 2 grams of Aluminium."[7]

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1. *Pogg. Annalen*, 11 p. 223.
2. *A Dictionary of Chemical Solubilities*, Comey. 1896.
3. *Comptes Rendus*, 38,279.
4. "Aluminium," its properties, metallurgy and alloys, by J. W. Richards, 1890.
5. *Handbuch der Anorganische chemie*, DAMMER, 2. 86 (1894).
6. *Gazz ch. it.* 22. 397.
7. *A Dictionary of Chemical Solubilities*, Comey. 3.

M. M. PATTISON MUIR,[8] states, in relation to the chemical properties of Aluminium, "it is scarcely attacked by $HNO_3 + Aq$."

WEEREN,[9] "Aluminium is soluble in $HNO_3 + Aq$. in *vacuo*."

STORER'S *Dictionary of Solubilities of Chemical Substances*, page 28, gives the one reference only regarding the action of nitric acid upon aluminium, viz.: "unacted upon by nitric acid, either concentrated or dilute, at ordinary temperatures, but is slowly dissolved therein on boiling."

N. MENSCHUTKIN,[10] "nitric acid has only a slight action upon Aluminium, the layer of nitric oxide formed protecting the metal from further attack."

IRA REMSEN.[11] "At ordinary temperatures nitric and sulphuric acids do not act upon aluminium: at higher temperatures however action takes place."

BIRNBAUM,[12] concentrated and dilute nitric acid, either cold or warm, are without action upon aluminium ("concentrirte und verdünnte Salpetersäure sind in der Kälte und Wärme ohne Wirkung auf Aluminium").

W. BORCHERS,[13] nitric acid is almost without action upon Aluminium. ("Salpetersäure ist fast ganz unwirksam auf Aluminium.")

FERDINAND FISCHER,[14] "nitric acid and sulphuric acid scarcely affect Aluminium."

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8. *Watt's Dictionary of Chemistry.* 1.142 (latest edition).

9. *Berichte. der d. chem. Gesell.* 24. 1798.

10. "*Analytical Chemistry*," by N. Menschutkin, London 1895. p. 65.

11. "*Inorganic Chemistry*," by Ira Remsen, N. Y. 1895. p. 562.

12. "*Handwörterbuch der Chemie*," Fehling, 1. 339.

13. "*Lexicon der gesamten Technik*," Lueger, Leipzig 1896, 1. 262.

14. "*Manual of Chemical Technology*" (Wagner), 13th German edition as remodelled by Dr. Ferdinand Fischer, p. 223.

J. ARTHUR PHILLIPS,[15] "Aluminium is not attacked by cold nitric acid, and only slowly on boiling."

AD. WURTZ,[16] "Nitric acid, dilute or concentrated has no affect upon Aluminium at ordinary temperatures. On boiling, however, solution of the metal is effected with extreme slowness."

ALFRED E. HUNT, JNO. W. LANGLEY, CHARLES M. HALL,[17] "Aluminium is unaffected by either concentrated sulphuric or nitric acids."

Encyclopedia Britannica. 1.647 states; "Aluminium is not attacked by nitric acid, even when the acid is concentrated..

CHARLES M. HALL,[18] "Sulphuric and nitric acids act upon aluminium with extreme slowness, not dissolving it appreciably after several days exposure to their action."

HENRY ROSCOE,[19] "Sulphuric and nitric acids, both diluted and concentrated, have no effect upon aluminium."

HANFORD HENDERSON,[20] "Aluminium is almost untouched by nitric and sulphuric acids."

G. A. LEROY,[21] "Sulphuric and nitric acids act immediately upon aluminium."

(Schwefelsäure und salpetersäure greifen das aluminium schnell an.)

R. L. PACKARD,[22] gives a résumé of the experiments of Le Roy, as follows:

"Le Roy used aluminium foil having the composition of

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15. *Elements of Metallurgy*, by J. Arthur Phillips and H. Bauermann, 528.

16. *Dictionnaire de chemie*, 1. 167.

17. "The Properties of Aluminium, with some information relating to the metal." *Trans. Amer. Inst. Mining Engineers.* 18. 537.

18. "The Properties of Aluminium." *Electrical World*, 17.390.

19. "Aluminium," *Nature*, 40.185.

20. "Aluminium," *Jour. Frank. Inst.*, 126.293.

21. "Action of sulphuric and nitric acids upon aluminium." *Chem. Zeit. Repert.*, 15.276. *Bull. Rouen* 19,232.

22. *Bull. U. S. Geological Survey*, 1893. *Jour. Amer. Chem. Society.* 15,221.

98.28 per cent. to 99.60 per cent. aluminium; 1.60 per cent. to 0.30 per cent. iron; 0.25 per cent. to 0.10 per cent. silicon.

The foil was polished, freed from fat with caustic soda, washed with alcohol, dried in the air bath, cut up, weighed and introduced into the acids.

	Temp.	Aluminium dissolved in grams per sq. metre 12 hours.
Pure HNO_3 sp. grav. 1.383.	15°–20°C.	17. grams.
Common HNO_3 sp. grav. 1.332.	15°–20°C.	16.3 grams.
Pure HNO_3 sp. grav. 1.382.	100°C.	Violent action.

According to these results almost pure aluminium 99.5. per cent, is attacked even in the cold by nitric acid.

Very elaborate experiments were made by G. LUNGE and E. SCHMID[23] regarding the action of nitric acid upon aluminium. They show that aluminium is readily attacked by nitric acid of 1.2 sp. grav. at ordinary temperatures and that with nitric acid of sp. grav. 1.5, the action is comparatively feeble.

The following table shows the results of the action of various strengths of nitric acid upon aluminium foil at ordinary temperature (20° C.), duration of test being ten days.

Specific gravity of nitric acid.	*Experiment I.* Milligrammes of Aluminium dissolved from 60 sq. centimeters.	*Experiment II.* Milligrammes of Aluminium dissolved from 60 sq. centimeters.	*Average.* Milligrammes Aluminium dissolved from 60 sq. centimeters.	*Average.* Milligrammes Aluminium dissolved from 100 sq. centimeters.
1.20	615.	617.7	616.4	1027.3
1.40	242.7	236.9	239.8	399.7
1.50	23.7	21.6	22.7	37.8

These experiments were conducted in the chemical laboratory of the Zurich "Polytechnikum."

23. *Zeitschrift fur Angewandte Chemie*, 1892, 7.

The aluminium was in the form of sheet metal, cut into strips of 80 mm. long, 27 mm. wide and 1 mm. thick. Its composition was: aluminium 99.2 per cent.; iron 0.25 per cent.; combined silicon 0.44 per cent., and crystallized silicon 0.11 per cent.

Messrs. Lunge and Schmid conclude as follows:

"Several experiments made by us convince us that the statements in the text-books, according to which aluminium is slightly or not at all attacked by HNO_3, are decidedly incorrect, which fact brings to naught the hope entertained that this metal can be used in the manufacture of nitric acid.

In confirmation of these tests I made the following experiments, using aluminium (manufactured by the Pittsburgh Reduction Co.) containing 99.6 per cent. aluminium.

Coarse turnings were made of the metal, and six samples, each of 1 gram, were transferred to glass flasks and treated as follows:

EXPERIMENT No. I.

Sp. Grav. of Nitric Acid	Amount of acid taken:	Number of days of test	Temperature of acid	Per cent. of Al. dissolved.
1.15	100 c. c.	7.	20° *C.*	94.2

I. Result=94.2 per cent. Al. dissolved.

EXPERIMENT No. 2.

Sp. Grav. of Nitric Acid	Amount of acid taken:	Length of test	Temperature of acid	Per cent of Al. dissolved
1.15	100 c. c.	20 minutes.	100° *C.*	100

II. Result=100 per cent. Al. dissolved

EXPERIMENT No. III.

Sp. Grav. of Nitric Acid	Amount of acid taken:	Number of days of test	Temperature of acid	Per cent. of Al. dissolved
1.35	100 c c.	7	20° *C.*	89

III. Result=89 per cent. Al. dissolved.

EXPERIMENT No. IV.

Sp. Grav. of Nitric Acid	Amount of acid taken :	Length of test	Temperature of acid	Per cent. of Al. dissolved.
1.35	100 c. c.	30 minutes	100° C.	100

IV. Result = 100 per cent. Al dissolved.

EXPERIMENT No. V.

Sp. Grav. of Nitric Acid	Amount of acid taken :	Number of days of test	Temperature of acid	Per cent. of Al. dissolved
1.46	100 c. c.	7	20° C.	12

V. Result = 12 per cent. Al. dissolved.

EXPERIMENT No. VI.

Sp. Grav. of Nitric Acid	Amount of acid taken :	Length of test	Temperature of acid	Per cent. of Al. dissolved.
1.46	200 c. c.	2 hours	100 c. c.	100

VI. Result = Complete solution.

These results show that aluminium in the form of coarse turnings is readily acted upon by nitric acid, hot or cold, the solution of the metal being more rapid in nitric acid of spec. grav. 1.15 than with the stronger acid of spec. grav. 1.45. In this connection no doubt the form in which the metal exists has a material influence upon the rapidity of solution in nitric acid.

If the metal be in thick plates, the action of the nitric acid is very much retarded.

N. Menschutkin, [24] considers that a layer of nitric oxide is formed, protecting the metal from further action of the acid.

To prove or disprove this statement, I selected a piece of aluminium (of the same composition as that which the above experiments were made), one inch long, one inch wide and one-half inch thick. This was placed in a large glass flask, 700 c.c.

24. "*Analytical Chemistry*," by N. Menschutkin, London, 1895, p. 65.

of nitric acid 1.35 spec. grav. added and kept at a temperature of 100° *C*, for five hours, when complete solution of the aluminium was effected. The result of these tests shows that while aluminium in thin foil, or coarse turnings, is easily dissolved in nitric acid, hot or cold, solution is materially retarded in hot nitric acid if the aluminium be present in thick plates, and that solution in cold nitric acid is practically *nil* under the same conditions.

The solution of aluminium nitrate which I obtained from Experiment No. IV., deposited crystals of aluminium nitrate in the form of colorless truncated rhombic octahedral crystals, similar in composition to those described by Ordway,[25] of the com position $Al_2(NO_3)_6 + 18\,H_2O$.

Ordway, however, obtained the aluminium nitrate by dissolving recently precipitated aluminium hydrate in nitric acid and slowly concentrating, the crystals having the form of colorless oblique rhombic prisms.

A. Ditte,[26] describes a basic nitrate of aluminium, obtained by the action of dilute nitric acid upon aluminium, of the composition $Al_2(NO_3)_2 + 4\,H_2O$. It exists as a white precipitate in the form of fine needles.[27]

I have failed to find in the bibliography of aluminium nitrate any reference to the formation of $Al_2(NO_3)_6 + 18\,H_2O$, by the direct action of nitric acid upon aluminium, as obtained in Experiment No. IV., above described.

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25. *Amer. Jour. Science*, [2] 9. 33.

26. *Comptes Rendus*, 110, 782.

27. *Handbuch der Anorganische Chemie*, Dammer, III. 106

COURSE OF LECTURES ON BUSINESS METHODS.

During the latter part of the second term a course of lectures on business methods was delivered to the members of the Senior Class. The first lecture of the course was prepared by Mr. Alexander C. Humphreys, '81, and was of an introductory character. Owing to ill-health, Mr. Humphreys was unable to read his paper and Mr. Harry de B. Parsons, '84, presented it in his stead. Mr. Parsons followed with introductory remarks based on his own experience. Both of these papers were presented March 23d.

The following day Mr. George R. Turnbull, Vice-President of the Guaranty Trust Company of New York City, lectured on "Double Entry Bookkeeping," and two days later Mr. William Sherrer, Manager of the New York Clearing House, addressed the Class on "The Relation of Money and Banking to Engineering Work."

Owing to lack of space the INDICATOR is unable to present all of these lectures in this issue: two of them are therefore reserved for the October number.

INTRODUCTORY REMARKS.

BY HARRY DE B. PARSONS, M. E., '84.

In order that you may fully appreciate these lectures on "Business Methods," it is necessary that you should have a clear conception of their object. It is intended that they shall open up before your minds a vista into the future walks of your professional careers, and for those among you, who are quick to perceive, they will no doubt help to smooth over many difficulties to be encountered on the practical side of life.

While not making you experts in any branch, they will bring to your attention such business subjects that are common

to us all; and will widen out your spheres of thought, so that you may be the better fitted to enter, a few months hence, into the real competition of the world.

Among the many requisites that are essential to the man of business, may be mentioned the following: Always give great credit to the talent of others, and never underestimate their ability. It is thus well to believe that your competitor is always stronger than yourself, and in order to achieve success that you must do your best. Be brief, clear and concise in your conversations and writings. Be decided and have an opinion of your own. Do not qualify your views with such expressions as "if," "I guess," "I fancy," as they weaken your standing in the minds of your hearers. When discussing professional topics with others, remember that as a rule you are better posted than they about your side of the subject, and that a clear and unequivocal expression of facts on your part will carry great conviction. Should you make an error, never hesitate to acknowledge it, as a manly admission never hurt a man so much as his efforts to cover over the mistake.

Train yourselves to take broad views of all subjects, and do not allow your ideas to be cramped by details. Study schemes, whether projected or finished, in their entirety remembering that when perfected the details can be worked out afterward.

The engineer of to-day must design his work not alone for its practicability, but also for its adaptability. The plan must be well adapted to suit surrounding and possible future conditions. This results in the fact that the most potent arguments for or against a project are those which arise from the business rather than from the professional standpoint. Some years ago when the British Government decided to supply its army, about to advance into the Soudan for the relief of General Gordon at Khartoum, with water pumped from the coast, it was decided to award the contract for the pumps to an American manufacturer. In reply to the criticisms put forward by the home makers, the government engineers replied that their decision was based on the fact that the concern in question was the only one which had actually built pumps for a similar service, and that they had no time for experiment or trial of other forms. This decision was

based on purely business grounds, while the professional part of the problem did not enter at all.

The province of the engineer has become so amplified as to include professional advice in many business councils. The capitalist is not satisfied with the answer to "what will it cost?" but demands a reply to "will it pay?" While the first query is of purely professional character, the second is founded entirely on business considerations. In short, the work must be so planned that the interest on the cost added to maintenance and operating charges, must be less than the receipts. As an illustration I have in mind a certain scheme which was excellent, *per se*, since there was an established trade. It became necessary to build a new structure to replace the old, and the professional men retained so ignored the business considerations of the problem as to reduce the company to a state of bankruptcy. Their purely professional work was no doubt well done, but so needlessly costly as to produce dire results through the enormous interest charges involved. A miscarriage in business judgment is just as damaging to one's reputation as a professional failure.

Remember that "money makes money" and that great consolidations appear to be the order of the day. In order to insure success, these combinations must be thoroughly "business like" in all details of management, which applies in no minor degree to the allied work of the engineer.

Since the capitalist stands as owner, he must be always the master, while the professional man remains as servant, because he acts in the capacity of assistant to carry out the former's views. Furthermore, the greater the position of responsibility, the more does the engineer's time become engrossed with business matters and the wider does he depart from his purely professional work.

In all operations, the legal questions that are involved directly or indirectly, must be treated as omnipotent. Under such conditions money is well spent in advance to secure the best opinions. As nothing in this world is too good to use, do not hesitate to secure the best of advice, and never rest content with that which is commonly called "good enough."

The subject of "Laws of Contract" is but one branch of legal work, and yet is sufficiently extended as to occupy the life

study of some of our most noted lawyers. Do not then imagine that you can become contract lawyers and at the same time keep pace with the developments of your own profession. Each different State has its own laws, and this fact complicates the problem to such an extent as to warrant your retaining a good lawyer to assist in drawing up the contract clauses to be attached to your specifications. Bear in mind that the courts interpret what you may write. You can call for any conditions that you please, but if the ruling of the courts be adverse, the actual meaning may be just contrary to your intentions. One of the most absurd as well as dangerous positions in which a man can place himself is that of a "know all." No man can expect to be well posted on everything. It is an absolute impossibility to know it all.

All such engineering work as the study of general plans for large enterprises, valuations, examinations and reports, places the engineer in the closest contact with the capitalist. It is, therefore, highly essential to have a knowledge of the principles involved in business methods, including book-keeping and accounting. It is often the case that the engineer can make a success out of failure through his professional experience coupled with his business knowledge.

Above all things be true to yourselves and be honest in your convictions. Do not assume responsibility which does not belong to you, but be ready to answer for your subordinates. A man who is not true to himself, cannot and must not expect the respect of the world.

THE RELATION OF MONEY AND BANKING TO ENGINEERING WORK.

BY MR. WILLIAM SHERRER.

This paper is headed "The Relation of Money and Banking to Engineering Work." Before beginning it, I should say that I have treated the subjects very concisely. It has not been my good fortune to read papers at young men's colleges before, and possibly I have not enlarged upon the topics here quite as much as you are accustomed to hear.

The relation of money and banking to engineering work does not differ materially from the relation to any other business enterprise. It is the function of the banks to extend credit facilities to any and all undertakings which commend themselves to the judgment of their managers. It will, therefore, serve the purpose of this paper to lay before you a concise view of the history and practice of banking in general, and thus illustrate the important mechanism known as exchange in its broadest sense,—involving not only the exchange of commodities *per se*, but the exchange of services and labor of all kinds as well. Money, which has been aptly termed the *tool* of exchange, becomes, by the assistance of banking, the great mechanical force by which almost all human activity is aided, encouraged and developed.

Money is utilized especially as a standard and a measure of values. In our modern life it has assumed various forms: metallic, in the shape of coin or bars; and paper representatives, including notes, drafts, checks, etc.

If you can imagine a state of civilization without money, you will at once conclude that during such a period, exchanges of products must have been attended with great inconvenience. For example, the shoemaker might readily obtain for the product of his labor a sufficient quantity of the butcher's commodities to last him several days; but since the butcher does not require shoes every week, the cobbler would be compelled to find some one requiring shoes who would have something to exchange therefor, which the butcher desired; and possibly it would be necessary to examine into the needs of a number of persons before the second exchange of shoes for meat could be effected. The introduction of a medium which the maker of shoes could obtain from anyone desiring footwear, and which medium would be entirely acceptable to the seller of meats, manifestly saves the several producers much time and labor, enabling them to produce more or increase their leisure hours.

It is not necessary to pursue the evolution of money in greater detail, inasmuch as the natural results following the use of this medium will readily suggest themselves to your minds. Nor is it practicable in a short discourse to do more than refer to the obstructions which the debasement of money and the

changes in the standard necessarily threw in the way of such a normal evolution as would have contributed marvelously to the more rapid developement of civilization. We must, however, give some attention to what may be termed the second great human invention for the advancement of commercial intercourse, viz., the introduction of banking. I do not intend to convey the idea that this was an invention in the usual sense of the word : it was in fact a plant of exceedingly slow growth, retarded for centuries by untoward events, and not until the present era has the great value of this handmaiden to commerce been properly appreciated.

The first bankers were merely money-changers, and the business was carried on largely by the gold and silversmiths, who were best able to judge the value of the thousand and one kinds of coins which the numerous great and petty rulers of the world put into circulation and which required continual adjustment. Gradually this class of individuals became the repositories of considerable sums of money, at first for safe keeping on account of having strong-boxes, and eventually for profit, for they soon found it practicable to loan out the funds deposited with them at interest, since the owners did not require them for immediate use ; and thus it became their business to induce persons of wealth to leave money with them, paying for the use of it. These goldsmiths were, hence, the intermediaries between persons having a surplus of money and those having need of loans ; reaping an advantage themselves from the difference between the rate of interest allowed and that which they demanded from borrowers.

Aside from the issuing of notes, to be considered further on, the function of banks remains practically the same to-day. It is their business to take charge of the money of one class of their clients, for or without consideration, and to provide the other class of clients with the sums needed for their enterprises ; and the profit is still derived from the difference between the interest allowed upon the deposits and that received upon money loaned, whether it be to individuals upon their personal obligations, or to corporations or governments upon their bonds.

As we have seen, the first bankers were individuals ; and to

all intents and purposes the description given fits the private bankers of to-day. When the practice of associating individual capital into corporations became prevalent, this was applied to banking business as well; and the great majority of banking offices in this country are now of the corporate kind. The advantages of this are apparent, affording, as it does, a means of combining a portion of the available means of a number of individuals in one enterprise, providing the power of supervision of the governing power, and definitely fixing the liability of each individual concerned, which in the case of a private banker is necessarily impracticable.

Several kinds of banking corporations exist in the United States at present: national banks, organized under federal laws and subject to visitation by officers of the federal government; state banks governed by laws of the several states; savings banks and trust (or loan) companies, also chartered by state authorities. Respecting the *banking* functions of the national and state institutions, no practical difference exists; the former, however, exercise the privilege of issuing notes; savings banks in the eastern states are not capitalized corporations, but are conducted by trustees, not for their own profit but for the benefit of the depositors; in many of the other states of the Union, savings banks are stock corporations organized for profit to those whose capital is invested; trust companies are similar institutions, taking considerable sums upon deposit for periods more or less fixed.

The chief elements of difference may be briefly stated thus: savings banks receive small sums for relatively long terms, paying fairly high rates of interest; trust companies receive larger sums for shorter terms, at lower rates; banks receive both large and small sums repayable on demand, and do not necessarily pay interest. Manifestly, in order to carry out their engagements, banks must have at all times a considerable reserve of unemployed money for immediate payments, while the other institutions require but a small fund for this purpose.

Let us now examine the effect of banking upon commerce and industry. Every depositor receives from the institution some form of evidence that the sums are held for him. In banks these sums are subject to check, *i. e.*, an order upon the bank to pay

out the money. In actual practice, it should be remarked, the class of clients known as borrowers usually also become depositors, the banks placing the sum borrowed to their credit subject to check. Assuming now that A, B and C have deposited in bank for current business $200,000; and D, E and F have borrowed from the bank $100,000, which has been placed to their credit; the bank has thereby increased the amount subject to check to $300,000. Multiply this instance several thousand times, and you have an exhibit of what is taking place in New York daily. Assume now that the individuals designated transact business with each other, the payments being made with checks, and it is readily seen that these paper orders take the place of the actual money and, aside from being more convenient, multiply the power of money many times. The sums are simply transferred from one account in the ledger of the bank to the other. Applying this to a considerable number of banks, it will be seen how much the evolution of the system has added to the forces available for the extension of human activity. Sixty-five institutions in New York City reported on Saturday last over $574,000,000 of deposits, and of actual cash less than $192,000,000; and this sum of money was $48,000,000 in excess of the proportion deemed satisfactory for the reserve purposes above mentioned.

To illustrate the banking process in the case of an engineering project, contemplated, for example, for the purpose of extending the operations of a railway: the officers of the bank would require that the managers of the railway company exhibit the financial condition of the property, its probable earning power and its obligations. The great utility of having all the details of the business of the enterprise clearly and accurately set forth in a balance sheet drawn up from the accounts of the company, is obvious. It is in fact impossible to exaggerate the importance of such an exhibit; for the question of the credit of a corporation is absolutely dependent upon it—its obligations cannot be placed without it; the machinery of credit cannot work properly without the accountant's intervention to certify that the borrower is solvent and carrying on a remunerative enterprise.

If the bank finds the exhibit satisfactory, the company's note is discounted, the credit is given and the sum involved is imme-

diately subject to check ; or, as is frequently the case with trust companies, the bonds of the railway corporation are taken and credit given either at once or upon their sale, which the trust company undertakes and in a measure guarantees.

It has been demonstrated that the power of money may be further multiplied with safety through the issue of bank notes—another form of paper representatives of money. The credit of an institution having been established, people in the vicinity are not loth to take, in lieu of the coin, a promise of the bank to pay the coin upon demand. The practice, which is of quite ancient date, has, until a comparatively recent period, been permitted to exist without restraint : private bankers, as well as incorporated institutions, very frequently issued large amounts of such promises to the confiding public beyond their powers to redeem them. The gross frauds thus perpetrated led to the legislative control of various kinds, under which the amounts of notes issuable is limited and proper provision for redemption made compulsory. Thus it is not uncommon to find a requirement that the note issues shall never exceed thrice the amount of actual cash in hand. This is regarded as a fairly safe reserve to provide for the notes that may be presented at any one time, and enables the bank by the use of its credit to give the coin held for the purpose a three-fold power in the commercial world. This does not, however, obtain in the United States, where banks which might otherwise avail themselves of the privilege under state laws, are prevented by a high tax upon issues of notes (10 per cent.) imposed by the federal government, which has chartered banks of issue specially. But these latter can use the privilege only upon deposit of government bonds, which are held by the Treasury as security to the note holder ; the banks are not required to provide more than one dollar in twenty for the purpose of the redemption reserve, which is also held by the government.

This might perhaps be made a little clearer by this illustration : a national bank in this city, desiring to issue $100,000 in circulating notes would be required to deposit $110,000 in government bonds with the Treasury Department in Washington. These bonds would be held by the Treasurer of the United States in trust for the note holders. Should that bank fail, or should

any of its officers run away with its money, the note holders would be amply protected—the United States government keeping the deposited bonds in Washington. In addition to that, the bank must also deposit in Washington legal-tender notes to the amount of $5,000 (*i. e.*, $1 in every $20) for the purposes of the redemption reserve.

Our system of banking varies, therefore, from the usual form: ours are banks of deposit and discount, but hardly banks of issue in the proper sense; moreover the systems in other civilized countries almost invariably provide for one large institution, to which is given the issue power. Thus the bank of England is the chief money issuing institution in Great Britain; it is, however, not authorized to increase the volume of the note-issues as above described; for beside a small amount emitted upon government bonds, its notes may only be issued upon deposits of coin or bullion; thus the function of augmenting the power of money is confined to its deposit and discount department; and when the ratio between its cash and the amount subject to check falls, it discourages the increase of loans and consequently of deposits and check-money, by raising the discount or loaning rate. This frequently results in the importation of money from places where the rates are lower, affording relief to trade and yielding a profit to the owner of such money.

The Bank of France on the other hand issues notes very freely within a limit fixed by law at 4,000,000,000 francs; which sum is deemed sufficient for all needs for many years to come. It is hence a much more useful institution than the one in London, combining, as it does, both of the chief functions for multiplying credit instruments; although by reasons of the facility with which the note issuing power can be used, the check system has not attained a high state of development.

The American system lacks a great regulative institution such as exist abroad; the forces available are not therefore utilized as much as they might be. Nevertheless, 10,000 banks and bankers with approximately $600,000,000 of cash, supply a present banking power estimated at $6,700,000,000; showing that through these intermediaries the commercial and industrial enterprises have the power of money increased in this respect

fully elevenfold. A much greater multiplication of forces is effected, however, by the system of clearing-houses, which it is profitable to examine in greater detail.

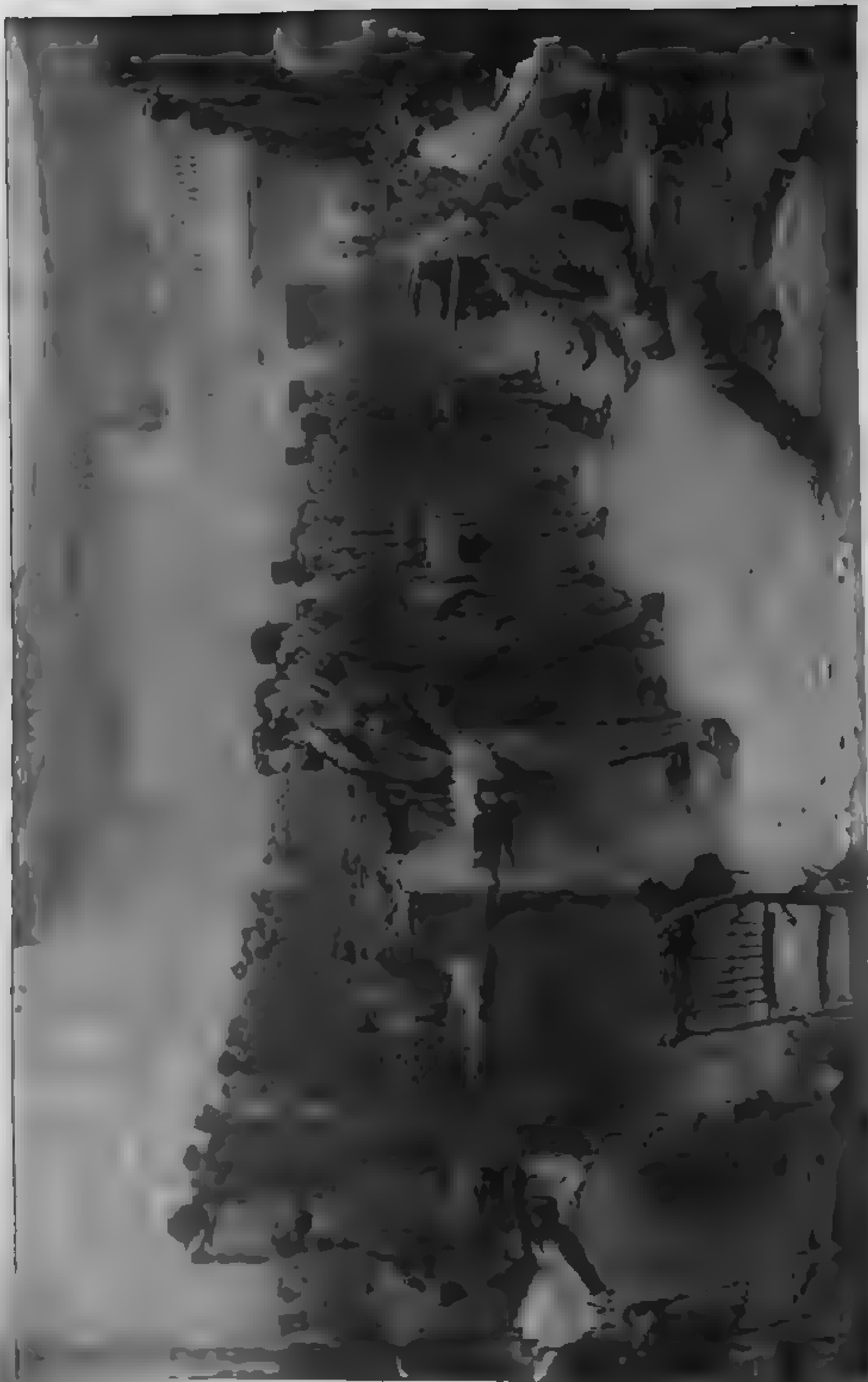
The system of bank clearings now in vogue in all the principal cities in this country is an example of how a small amount of money may be made to settle a large amount of business. The work of the New York Clearing House is an example of the economy. The records of that institution for forty-three years show that but $4.65 per $100 is all the actual cash needed to transact the business of the New York banks.

Let me give you a brief description of its work—and here let me say that it would afford me great pleasure to have any or all of you young gentlemen call at the Clearing House and see the actual workings of that institution on any business day.

Prior to the establishment of the Clearing House, banks were obliged to present the checks and drafts received by them on deposit directly to the banks for payment—I refer to checks on banks in New York City. At that time there were over fifty banks in New York and some fifteen or twenty in the adjacent cities of Brooklyn and Jersey City. The labor of visiting each of the banks daily and collecting the cash in gold or currency called for by the checks was very great. and the attendant risk of loss by robbery was considerable. It was a daily occurrence for one bank to have many thousands of dollars more against another bank than that bank had against it, and in turn have many thousands of dollars less against another bank. The constant adjustment of balances and the necessary transportation of money through the streets, the loss of time and the expense of the work, called for some improvement in the manner of transacting the business.

This was solved by the establishment of a central place, where each bank in the association could be represented by a clerk authorized to receive all checks chargeable at his bank and at the same time, with the help of an assistant, present the checks his bank had against every other bank to their representatives. Thus we had one, in place of fifty-six.

Let me describe the process of clearing: there are sixty-six banks who are now members, and seventy-seven non-members



whose checks are cleared by member-banks. Each of these members is furnished with a desk; the desks are arranged in numerical order. The clerk of each bank takes his seat at his desk; the messenger stands in front of the desk with the checks of his bank arranged in separate bundles, one for each bank. At the signal each messenger advances and deposits with the clerk at each desk the bundle of checks for that bank. The tour of the room is made in ten minutes; when the messenger reaches his own desk, after making the tour, the packages of checks which have been received by the clerk of his bank are awaiting him. These he places in his now empty box and returns to his own bank. Thus, in less than one-half hour two men have presented for payment all the checks which their bank held against one hundred and forty-two other banks,—sixty-six members and seventy-seven non-members,—and received all the checks presented against their bank by all the others.

Under the old plan it would have required the services of at least ten men for one entire day to do the work of presenting checks for payment received by one of our banks in one day's business. This represents the saving of time now, as well as to the use of a small percentage of money to the amount of checks brought to make the payments or settle resulting balances. Take the case of bank A as an illustration: we will suppose that bank A takes to the clearing house checks drawn on other banks amounting to $1,250,000; for this amount that bank is credited on the books of the clearing house; after the delivery of packages has been finished and the clerk of bank A has made a list of the amounts the other banks have presented against his bank and footed them up, he finds that amount to be $1,200,000; the result showing that bank A is credit $50,000. Why? Because the amount of the checks that that bank had against all other banks exceeds the amount all the other banks had against it to the amount of $50,000; so that the condition of each bank is soon shown for that day. Each of the sixty-six members will be debit or credit, as will be shown by the differences between the total amount of the checks brought and received by each. The balance sheet of the clearing house of the day will show which is debit and which is credit. The total of the amount

of checks brought to the clearing house will, of course, be the total of the amount taken away; as of course the total of the debit balance will equal the total of the credits.

Now, as to the final settlement of these balances: the debit banks,—or those who brought less than they received in checks,—must pay the difference to the clearing house in actual cash by a certain hour. After the debit banks have paid the amount owed by them, the credit banks are paid the amount due them caused by their having brought more to the clearing house than they received in checks.

In this description of detail, I may have caused you to lose sight for the moment of the principle of economy in the use of money, as well as the saving of time, that makes the clearing house system the useful and important aid that it is to the banking and business community.

The exchanges at the New York Clearing House average at the present time $90,000,000 per day. Were it not for this system, this, or most of this, large sum would have to change hands daily with the attendant risk of loss. Now we find that less than five per cent. of actual cash is needed to settle the balances resulting from the exchange.

You will observe that the bank is either debtor or creditor of the clearing house and not to the individual banks (or *members*, as they are called); consequently they make one settlement instead of one hundred and forty-two.

Bank clearing-houses have proved so useful to the banks and business men that there are now seventy-two of them in operation in the United States, all working upon the same plan as the Clearing House in New York City.

Thanking you for your attention, permit me to say in conclusion that in this lecture I have been able to give only the outline or a mere sketch of money and banking and their relation to business. As all business and professional work is largely dependent upon the bankers for success, let me urge upon you the necessity of acquiring a knowledge of the ordinary details, at least, of this important help to your future growth in your profession. It is an old and time-worn saying that "Knowledge is Power." He that would have power must work and deserve it.

"MODERN EDUCATION—DOES IT EDUCATE IN THE BROADEST AND MOST LIBERAL SENSE OF THE TERM."

A series of articles on the above subject is now in progress in the *Cosmopolitan* as announced in the April INDICATOR. The June number of the magazine contained President Morton's article in which he pointed out that until a comparatively recent period the classic languages and literature, together with a certain amount of mathematics and philosophy, were the first subjects to be "reduced to such a systematic organization as to be fit exercises for training the faculties and developing the judgment," but that at the present time there is no reason why the modern languages and the sciences may not be so systematically taught as to produce a mental training of equal value, especially to those whose "minds, often unusually gifted in other directions, lack what might be called the power of word-memory, and to which, therefore, linguistic studies present special difficulties."

The ethical influence of education was treated much to the advantage of a "liberal technical" training. President Morton deplored the modern tendency towards "trickery and juggling with words in absolute disregard of facts, and the disposition to build upon inequitable technicalities in defiance of the most manifest principles of right and wrong," and pointed out that this disposition was fostered by the "plausibilities, sophistries and self-delusions which so insidiously beset the pursuit of metaphysics, dialetics and rhetoric," in marked contrast to the "sincerity of purpose and the intellectual honesty which are bred in the laboratories of chemistry and physics—where the student would scarcely know how to defend a thesis which he did not himself believe; where the only success he has hoped for has been to be right, the only failure he has had to fear was to be wrong, and where, to be brilliant in error only heightened the failure, making it the more conspicuous and ludicrous. How wholesome to the mind and heart of the pupil is such a regimen!"*

* From an article contributed by the late President Walker of the Massachusetts Institute of Technology to the *Educational Review*, October, 1891.

President Morton also treated of the policies pursued by many of the technical schools that have come into existence in recent years and declared that the most successful educator is the one who does "not hasten to meet the demands of the present by turning out the article most desired, irrespective of its intrinsic value and enduring qualities, but the one who labors to produce the best possible product, trusting to the future to vindicate and crown his work." He also said that "our entire systems have been and are now in the direct line of evolutionary development and that the development has been and is proceeding at a rapid rate and in a true, because natural, direction."

Home influence as a factor in liberal education was considered. In conclusion, the "*education of the educators while they are teaching*" was strongly advocated especially for the teacher of the arts and sciences who should lose no opportunity to act as investigators, and to keep themselves, by personal observation, in touch with the contemporary development of their subjects."

A LECTURE ON INDUCTANCE.

BY DR. WILLIAM E. GEYER.

ABSTRACT BY ALB. F. GANZ, M. E.

On the evening of May 25th Dr. Wm. E. Geyer delivered a lecture on "Inductance" before the Brooklyn Institute of Arts and Sciences. The lecture was illustrated by numerous experiments in which the doctor was assisted by Alb. F. Ganz, M. E., and by Mr. Fred Ophuls. Various appliances of the electrical department, including the large electro-magnet and the high frequency alternator, were taken to Brooklyn for the occasion.

By means of the large magnet, which has a time-constant of several seconds, the lag of current behind the E. M. F. could be directly illustrated. For this purpose lamps connected in series with the magnet served as an ammeter, while a lamp placed in shunt with the supply circuit served as a voltmeter. The current was taken from the Edison lighting system.

Upon closing the circuit the voltmeter lamp reached full brilliancy practically at once, while the ammeter lamps required

several seconds, showing that although the supply voltage was present at full value the current in the inductive circuit was delayed. When the circuit was interrupted rapidly enough by means of a switch, the ammeter lamps would not light at all, while the voltmeter lamp remained incandescent ; the pressure in this case was not left on long enough at any time to allow the current to reach sufficient strength to show in the lamps. A lamp was then connected directly across the terminals of the magnet ; owing to the extremely low resistance of the magnet it did not light while the current was flowing through the magnet. When this current was interrupted, however, the lamp lit up brilliantly for a moment, showing that the current in the magnet kept on flowing after the pressure supply had been removed.

A novel experiment was the following : Two similar coils of insulated wire, wound for maximum inductance, were suspended freely from the ceiling in a manner allowing them to rest freely against one another. When an alternating current was passed through the coils they would either attract or repel, depending upon their relative positions. If, while in position for repulsion, the current was started, they would fly apart, turn around into position for attraction and cling together, extinguishing at the same time a lamp in circuit with the coils. This is a direct illustration of the law that "Every circuit tends to so arrange itself as to make the inductance a maximum."

Numerous other experiments, together with the clear explanations given by the doctor, rendered the lecture entertaining as well as instructive, which was evidently appreciated by his audience.

COMMENCEMENT WEEK.

BACCALAUREATE SERMON.

The exercises of Commencement Week began auspiciously with the baccalaureate sermon which was eloquently delivered by the Rev. George Clarke Houghton. D. D., in the Trinity Protestant Episcopal Church. Hoboken. to an unusually large percentage of the graduating class on Sunday. June 13th. Dr. Houghton chose for his text: "Let every man abide in the same calling wherein he was called." from I Corinthians vii. 20. He said, in part:

"There is in evidence no example of the original perfect creation of humanity. Whatever ignorance and culture have left of their onslaught the nether world has tried to eliminate. Yet the fragments show what it must have been in all the beauty and power of its primal state and its possibilities now under grace. Yet in mental and moral faculties one finds manhood endowed with a generous and munificent series of ornaments and I ask you, my young friends, as you stand with your feet upon the threshold of life, what do you propose to make of these divine gifts? Which way do your thoughts set?

"You can brace yourself against those influences which would direct your aims and ambitions to the highest plane of human life, but let me tell you, that act will recoil upon your after life. Do not for a moment suppose that such a bracing is courage. Be inspired by faith –faith in the Supreme Benefactor of mankind from whom you have received such gifts; faith in the integrity of your purpose; faith in yourself. And to faith add virtue, good judgment and temperance and patience in bearing well the disappointments and failures of life. The precepts of the Christian religion are the golden precepts of the secular life. Christ, by his working life, raised the whole level of man's working life to the plane of the Christian life. Every hour of honorable toil in secular pursuits is a storage for the highest Christian life.

"In the world you will meet with an army of those whose rule is that every man should do what is right in his own eyes. And yet the 'wisest man' said that 'the way of the fool is right in his

own eyes.' Wadsworth's advice was 'to take the highest for a model.' Not notoriety, nor attainment of wealth, nor applause. They are not 'success.' But self-restraint is success. Self-restrained men are God-fearing men, and no man whose life has been a success has been a Godless man. All we have is but borrowed from God, and to Him we must account for their use or failure. Lift all your planning to that level."

CREMATION OF CALCULUS.

The cremation of calculus occurred with the usual pomp and ceremony Monday night. The parade of students grotesquely costumed and led by Prof. McDermott's band, started from the Institute at 8.15 P. M. and marched through the principal streets of the town, much to the amusement of the populace who turned out in large number to witness the queer antics of such apathetic mortals as could revel in the presence of a sombre coffin and cabalistic banners.

The procession returned to the campus where the funeral pyre of calculus was burning fiercely. A hasty trial was given this troublesome spirit who was prosecuted by G. W. Martin and defended by R. P. Jennings. Judge J. R. Westerfield decided, without hesitation, that calculus was guilty and his body was immediately consigned to the flames which enveloped him, while the joyous sophomores danced about the scene uttering demoniacal yells and singing college songs.

PRESIDENT AND MRS. MORTON'S RECEPTION.

The most welcome reception, tendered each year by President and Mrs. Morton to the Faculty, Alumni and Graduating Class was held on Tuesday afternoon from four to seven. Notwithstanding the threatening weather a large number were present to exchange greetings with their very amiable host and hostess and with each other. The sultry weather was forgotten by the guests, who roamed at will through the spacious parlors laden with the fragrance of sweet flowers, and on the large veranda, enjoying at the same time a most tempting and refreshing collation, and the company of friends who formed in ever changing groups.

REUNION OF THE CLASS OF '88.

The triennial dinner of the class of '88 was held at Meyers Hotel, corner Third and Hudson Streets, Hoboken, on Tuesday evening, June 15th, and proved to be a very pleasant event. Mr. Paul Doty presided and Prof. Riesenberger was the guest of honor. Those in attendance, in addition, were Richard Beyer, N. St. George Campbell, Edward Ducommun, John V. L. Pierson, William B. Yereance, and last and smallest but the most notable, the 8-year-old son of Mr. Yereance, who has the honor of being the first child born to a member of the class of '88, for which he has received a class prize, a handsome silver cup. He is known as the "prize-boy" or the "class-boy."

Regrets from a number of class-mates were read, among which was one from Alten S. Miller, who has been confined to his home with malaria.

Everybody was in a reminiscent mood and related stories and humorous tales of Institute life as well as giving narratives of experiences enjoyed since graduating from the Institute. It was decided to make more elaborate preparations for the tenth anniversary dinner next year.

Resolutions were passed extending the appreciation of the class for the services of Professor Mayer and also their sympathy for him in his present illness.

The members adjourned about 8.45 P. M. to attend the meeting of the Alumni Association.

ALUMNI MEETING.

The annual meeting of the Alumni Association was held in the hall of the Stevens School, on Tuesday evening, June 15th. A full account of this meeting will be found elsewhere in this issue.

CLASS DAY EXERCISES AND RECEPTION BY MRS. STEVENS.

After a lapse of two years, the Class Day Exercises which together with Mrs. Stevens' reception form one of the most delightful events of Commencement Week, were most successfully resumed by the Class of '97. The exercises were held on the beautiful grounds at Castle Point, Wednesday afternoon, and a very large assemblage was present to enjoy the occasion. On the grassy lawn, just to the south of the old castle, a small platform

had been erected and about it, chairs had been arranged in a semi-circle, forming a sort of open-air amphitheatre. The scene was an indescribably pretty one, the bright colors of the gowns worn by the ladies contrasting with the natural beauties of the place, forming a picture that was indeed pleasing to the eye.

Mrs. Richard Stevens, who afterwards entertained the graduates and their friends, looked after the comfort of all and made an ideal hostess. Shortly before four o'clock the graduates, who had gathered on the other side of the castle, came into view, marching two abreast. They first gave an intimation of their approach by a series of college and class yells.

When the students had arranged themselves in recumbent attitudes in a semi-circle about the platform, the class was called to order by Mr. Walter Kidde, who made a brief address of welcome. Mr. Henry Samuel Morton then called the roll according to the *noms de plume* by which the boys knew each other.

The reading of the class history was next in order, that duty having been intrusted to Mr. O. M. Kelly, who accredited himself splendidly with a witty effusion of prose which gave way later to a poetic strain of doggerel verse in which his classmates were hit often and hard.

The vocalists of the class then grouped themselves and sang a parody on "The Soldier's Farewell," which was addressed principally to the Faculty.

Mr. W. D. Ennis arose to prophesy the future of his classmates, which he did in a novel and eloquent manner by generalizing rather than by prophesying for each member in turn.

A very humorous topical duo was sung by Mr. G. D. Williamson and Mr. John Munby, and was enjoyed immensely by the audience.

The presentations were made by Mr. George P. Richardson, who, by his inimitable and assumed autocratic manner, placed many of his classmates in humorous and somewhat embarrassing positions, which were greatly enjoyed by a merciless audience. Every member of the class was remembered and many of the gifts were exceedingly unique.

The exercises were concluded by the Stevens song, "Mechanical Engineer," in which the entire class took part.

After the exercises all were invited into the castle, where refreshments were served. The guests were received by Mrs. Stevens, whose kind hospitality in throwing open the historic grounds and the magnificent home, was thoroughly appreciated and enjoyed.

COMMENCEMENT EXERCISES.

The Commencement exercises were held in the Lyric Theatre, Hoboken, Thursday evening, June 17th,.before one of the largest audiences that have ever graced a similar occasion.

Promptly at 8.15 o'clock the orchestra began the overture and the Faculty and guests marched in two's upon the stage, followed by the members of the graduating class, similarly arranged, from the opposite side.

The exercises were opened with prayer by Rev. Archdeacon Jenvey, who invoked the Father to bestow upon the young men about to go out into the battle of life, wisdom and strong moral character, imbued with divine will.

President Morton then arose and delivered the introductory remarks in a happy strain. He said:

Ladies and Gentlemen:

As I rise to address you to-day, I am naturally and forcibly reminded of a like occasion a year since when, under similar circumstances, I introduced the ceremonies at our last Commencement.

Then, as I remember, the prominent idea in all minds was the near approach of our Twenty-fifth Anniversary, or Silver Wedding, which we were arranging to celebrate; now this is passed, and we can only look back upon it, while we look forward to our Golden Wedding as the next Anniversary for which we must make adequate preparation.

In this combined looking backward and looking forward there is a vast amount of pleasure and encouragement; pleasure in the contemplation of what we have done, and encouragment as to the even greater things which we may naturally expect to accomplish in the future, with the accumulation of experience and increase in facilities which we now possess.

Looking backward we see how from a teaching force of eight

in our Faculty we now have eighteen, while we have added to our material appliances well-equipped work-shops and foundries, an entire department of Applied Electricity, with dynamos, motors and all sorts of electrical instruments, and a course of Experimental Mechanics involving the practical running of prime motors of all sorts and measurements of power and efficiency.

Turning again to our "output," we find a change from a first graduating class of *one* to the present class of *sixty-one*.

All this, moreover, has been reached, not by the application of exterior force, not by great or frequent additions to our original moderate endowment, but substantially by the natural growth and development of an interior vital principle.

The Institute may be compared to a young apple tree, of good stock and strong vitality, which, being well located, draws from its environment what is necessary for its growth and fruitage. At first it was a mere sapling, and on its first year of bearing its crop was one apple. But that one was a good one, and ever since the harvest has increased until now the yield is enough to fill many baskets. (Pointing to the graduating class and the several baskets full of diplomas awaiting delivery.)

I think I may say also, that good as were the early crops, the later have improved in individual size and flavor, and since the early ones are now at the head of large establishments, or in prominent professional practice, we may well hope that long before the next twenty-five years have glided away each one of those who graduate this evening will have achieved at least as great success.

As some of you may know, I have been recently attending the commencements of two of our great universities on my own account (An allusion on the part of the speaker to his having, within the previous few days, received the honorary degree of Sc.D. from the University of Pennsylvania and of LL.D from the Princeton University.—Editor.), and I am pleased to say that, without disparaging in any way the quality of the vast classes which these institutions are graduating, I have felt more than ever proud of that of our own. We do not have such a variety of fruit, medical, classical, theological, dental, artistic, mining, metallurgical, etc., etc., as I have seen elsewhere, but if

ours are all of one sort, they are likewise one and all specimens of that sort worthy of carrying off the prizes at agricultural or other exhibitions, and, indeed, well equipped to win prizes in the great race and contests of life.

Indeed, it seems to me that a looking back upon the progress the Institute has made in the past may fairly encourage us in a looking forward with brightest hopes as to the greater results to be accomplished in the future.

Not only may we count upon good results in the near future, but, looking ahead still further, we may imagine a "manifest destiny" for the Institute on the general lines of that suggested for the United States at a dinner held at Paris, among the American residents thirty odd years ago during the war of secession:

The first toast proposed was as follows:

"To the United States bounded on the north by British America, on the south by Mexico, on the east by the Atlantic and on the west by the Pacific Ocean."

This having been duly received with enthusiastic cheers, another gentleman rose and said. "The speaker who has just addressed you has, it seems to me, failed to take into account the manifest destiny of our great and growing country, and having this manifest destiny in view I would propose—'The United States bounded on the north by the North Pole, on the south by the South Pole, on the east by the rising and on the west by the setting sun.' Still more enthusiastic cheers saluted this announcement, but when they subsided, a gentleman of solemn and sober countenance from the far west arose and said. "Fellow Citizens, if we are to take into account the Manifest Destiny of our beloved country, then I for one must decline to accept the narrow limits indicated by the gentleman who has just taken his seat. I propose—'The United States, bounded on the north by the Aurora Borealis, on the south by the procession of the Equinoxes, on the east by Primæval Chaos and on the west by the Day of Judgment."

The orchestra then rendered several selections from "Prince Ananias," after which the salutatory address was delivered by H. Donald Tiemann, as follows:

Mr. President, Members of the Stevens Institute, and Friends:

As the stars shine out one by one in the darkening sky, ever glowing with the same brightness, while the objects so plainly seen by day grow dim and disappear; so are there events in the experiences of every person which all through life stand out ever clear and distinct upon the fading scenes of memory.

Such a star will the events of to-night become to every member of our class, the class of ninety-seven. Its brightness, however, will not be alike to all, for with some, other interests will outshine it, while with others, who have long looked forward to the time when it should rise upon their vision, its light will not be that of a lesser magnitude.

It is this event in our lives that you, friends and instructors, are helping to make one of great happiness by honoring us with your presence here to-night; and I, speaking for the class of ninety-seven, thank you for the kind interest you have thus shown, and extend to you a cordial welcome.

Looking back upon the rough and winding path by which we have ascended to this present vantage-point, things stand out in a new and a clearer light. We can better now appreciate the pains and the care taken by those who have guided us on our way. In behalf of the class, I thank them, and congratulate the future classes which shall come under their care. One of their number, our honored and beloved Professor of Physics, has been obliged, through illness, to leave their ranks for a time. We rejoice that we have been permitted the privilege of his guidance, and sincerely hope that those who, in the future, shall climb these steps, may not be compelled to do so apart from his presence, for we know how great a loss that would be—a loss that no one can replace. To him we extend our best wishes for his speedy and complete recovery.

Will you think it egotistical if I dwell here a moment upon our class. In '93 we entered the Institute with 86 members, 71 per cent. of whom await their diplomas to-night, and although we fall just short of the largest number ever graduated from the Institute, we have the satisfaction of knowing that the previous class graduated but 58 per cent. of their original number.

"A rolling stone gathers no moss" is an old saying, and—well, we haven't been gathering much moss in the past four years; but the stone must keep on rolling, and we must keep on going; and is it not our duty to our Alma Mater to do as much and be as great as we are able, that those who see our success may say, This is a Stevens man! But there is a duty we owe, more sacred than this. Base indeed is the man who does not feel his obligation to *be* a man, if not for himself, at least for the sake of his friends, and his father and mother.

Over the great central arch of the Peristyle, the entrance to the Court of Honor and the Dream City, were inscribed these words, "*Ye shall know the truth and the truth shall make you free.*" A splendid place for such a saying,—at the gateway to the greatest monument of the learning and achievements of the whole world. But there is a better place still to inscribe these words: on the gateway to the heart. During these four years we have been learning to seek after the truth. But what is truth? The same who spake these words, crowning the entrance to the World's Fair, also said, "I am the way, the truth, and the life." There is something higher, something nobler for us to strive after than wealth or fame or honor, for those who seek only these things become slaves to them and know not the Truth; but they who find this Life are free.

The question comes to each one of us now, how shall I obtain success in life? Let us look to the Great Teacher and learn of him. "Seek ye first the Kingdom of God and his righteousness, and all these things shall be added unto you." And just in so far as I live up to this command, so far will my life be a success; and no life, however humble or however great that makes this teaching its purpose, can ever be a failure.

Classmates, I wish you success.

Mr. Henry R. Towne, President of the Yale and Towne manufacturing Company, of Stamford, Conn., in his address to the graduating class gave much advice to the young men that will undoubtedly prove of great value if persistently followed throughout their careers. Mr. Towne's address was listened to with the utmost attention and is here given:

Mr. President, Ladies and Gentlemen, and Students of the Graduating Class:

Recognizing that I have been invited to speak to the members of the graduating class, I will claim the privilege which this implies of addressing myself to them rather than to the audience which is gathered here this evening to greet them and to congratulate them upon the completion of their college course.

During your course you have had the high privilege of receiving instruction from the able professors of the Stevens Institute in all that relates to the theory of your chosen profession. You are about to undertake its practice and I propose to offer a few words of counsel and suggestion in this connection prompted by my experience as a manufacturer and employer of many men and an engineer who has had experience of the kind which presumably lies before many of you.

A most marked characteristic of our times is the tendency towards specialization of work in almost every field. Heretofore the courses in our technical colleges have not included instruction in industrial management. Already, in a few cases, efforts are being made to remedy this deficiency, and although I have not discussed the subject with my friend, President Morton, I venture to predict that in due time it will be incorporated into the courses of the Stevens Institute. Meantime, however, you who are graduating now must follow the same paths as your predecessors and seek after graduation to acquire as promptly as possible that insight into practical work which will be most helpful and which, to a large extent, is essential to the successful application of the theoretical knowledge which you have here acquired.

A marked feature of the specializing tendency referred to is the steady concentration of industrial enterprise into larger and larger units.

Aside from the vocations of teaching and research the logical goal for the ambition of the graduate of a technical school is a position in one of these aggregations of industry, and this, in most cases, almost inevitably implies the combining of commercial and executive duties with work of technical character. In other words, positions relating chiefly to scientific or technical

operations involve nearly always more or less of executive responsibility. I assume without question that your ambition aims to attain in due time the higher rounds on the ladder of promotion. If so, it is essential that you should at once begin to supplement your technical knowledge with the study of the art of industrial management and thereby to qualify yourselves for its responsibilities when your opportunity arrives.

Heretofore the problems in your work have involved the factors of quantity, stresses, forces and resistance. The problems of your future work will introduce a new factor, namely, *the dollar*, and you will discover that almost all of the equations of practical work resolve themselves finally into questions of relative value. The final outcome of all work is or should be a profitable result. The science of industrial economics, although as yet possessed of little literature, is a necessary and most important factor and constitutes a field of work and effort offering the highest prizes to success. The application of scientific knowledge to the attainment of practical ends is not only no derogation of science, but, on the contrary, constitutes its highest phase, namely, the advancement of productive industry and the attainment of profitable results. The combination of technical with commercial and and executive abilities which this implies is not common, and the possession of such abilities offers the best assurance of advancement and success to the young engineer. To the acquirement and development of these qualities he may wisely devote his best energies.

The concentration of industry into large units, already referred to, implies the corresponding need of men capable of effectively directing the vast operations thus involved. Large employers fully realize this and are constantly looking for men capable of filling the higher positions in organized industry. It is essential to remember that work of this kind is two-fold in character, involving on the one hand scientific and technical knowledge, and on the other ability and experience in work relating to management, to organization and to commercial affairs. For the former you have laid the foundation during your college course. For the latter you have yet to qualify by practical work, accompanied by constant study and development. In both the

full measure of success can only be reached by permanent habits of observation, investigation and such recording as will make the growing fund of experience always readily available for practical use. An engineer's note-book should be the most useful volume of his library, and the same may usually be said of the system, whether by note-book, card index or otherwise, whereby any man of affairs records the important features of his experience and makes them available for his future work.

It was my privilege nearly thirty years ago to present a letter of introduction to the engineer, David Kirkaldy, the father of systematic testing of materials, at his offices in London. While waiting for the messenger to present my card I noticed over the door leading to his inner office the inscription, "Facts, not opinions." No better motto can be adopted by any engineer, and the idea it embodies should form the keystone of all work relating to applied science in its commercial, equally with its theoretical, aspects. To this end cultivate the habit of observation. Study and inquire how work is done, and why; keep a record of these observations and impress them on your memories. Seek counsel from those about you, from your superiors if you can, from your equals, and especially from your subordinates. Having obtained such counsel, however, make your own decision in matters for which you are responsible, and then stand by the results. The fear of assuming responsibility is a handicap which hampers many young men. Caution and sound judgment in reaching a conclusion, and courage to adopt it and to give it effect, are qualities in leadership which employers are glad to note and which usually command recognition in due time.

A vital element in industrial management is the science of accounting, of recording accomplished results and of intelligently analyzing them. Accounting is in fact a science based on exact principles and having well established principles and laws. The application of these may vary widely under varying conditions, but certain elemental principles underlie all such work. These should be studied and mastered. The best efficiency in management is only possible to one who intelligently understands the correct principles of accounting and who can thus organize, or at least intelligently direct, the work of this kind which necessarily

pertains to and is closely interwoven with the work of current production and management.

In like manner, seek to utilize all reasonable opportunity for embodying the results of your work in concise, well stated reports, whereby its outcome will be brought effectively to the notice of your superiors. Too often employers do not appreciate the good work of the younger men about them because it is not brought to their notice. A good system of reports on current matters should constitute a feature in all large industrial organizations. If it exists avail yourselves of it. If it does not, seek to initiate it by voluntarily reporting from time to time upon what you are doing in a form which will be useful to those who employ you by placing the facts before them in an interesting manner, and which incidentally will serve to call attention to the quality of your work and to suggest your ability to undertake larger responsibilities.

Finally, remember that in all work, whether technical, commercial or executive, there is one supreme quality higher than all others, and embracing the maximum value, namely, the quality of *thoroughness*. Be thorough in methods, in work, in study, and especially in language. Care and accuracy in the use of language are recognized necessities in scientific work and are equally valuable in practical affairs. Looseness or ambiguity in words, whether written or spoken, inevitably suggest corresponding qualities in habits of thinking and work ; they are the antitheses of accuracy and reliability. Above all have enthusiasm. Put your heart into your work, do your best and then feel and display self-confidence. These qualities, backed by fair ability, will win success in any field. Employers are always ready to welcome young men who show these qualities, and, when they can, to give them opportnnity for advancement. On their behalf I greet the members of the Graduating Class with best wishes for their future success.

The last roll-call of the class of ninety-seven was made by Mr. S. B. Dod, President of the Board of Trustees, who, as each name was called, extended the much coveted diploma to an eager recipient, after which the Degree of Mechanical Engineer was conferred.

Several members of the class, who had secured and were filling positions at distant places, were unavoidably absent. Mr. Dod also made the announcement that Felix Layat had won the Stevens School Scholarship.

The valedictory address by William D. Ennis was a most eloquent one. Several times during its delivery he was interrupted by applause and laughter, and at the conclusion there was prolonged applause, which subsided only after he had responded several times. Mr. Ennis not only received the congratulations of his friends but of the entire faculty as well. The address follows :

Mr. President, Gentlemen of the Trustees and Faculty, Classmates, Ladies and Gentlemen :

This is a proud hour for the class of Ninety-seven. The crowning time of our student life has come, and in the triumph of this moment there is mingled no alloy of bitterness. Perhaps never again shall we experience so complete a sense of victory as at this moment we feel, holding in our hands that honor for which we have been patiently striving for the last four years; and never again, in all certainty, shall we possess so completely the sympathy of our auditors. For each one of you, our friends, there is some tie of more than passing interest, which makes this *your* commencement because it is *ours.* You will not need, then, to forgive our elation, for you will rejoice with us. You will not look coldly upon our emotion, for you will understand the lingering regret that we must feel as we realize that these bright college days are now forever past, and that though we may visit the old halls again and again, it will be no longer as a part and busy portion of that life, but only as the shadowy memory of a bygone day. You will smile kindly at our youthful hopes and ambitions, for you, with all the world, believe in the young man's ambition. In everything, to-night, your hearts are with us, and your presence and sympathy will make these ceremonies even more resplendent to memory, as we may look back upon them from future years.

We feel that it is our right to be proud, as we look forward to the profession which now we may call our own. What broader scope for the exercise of abilities and training could the

most ambitions of Parnassians desire than that of modern engineering? We are not to think that the day of the sage has gone by, that the age of the seer is past, and they have gone by, and are past in great measure. Life is too busy and the world too active for men in this century to shut themselves away like an Archimedes, isolated from human society, human desires, and human needs, in the contemplation and investigation of truth. The day of the hermit of science is gone by; he is a relic of a past era who would study Nature by himself and through himself alone.

In his stead there has dawned upon this world the genius and fire of a new philosophy. He who would know the laws of Nature must learn to know the laws of human thought, and he who would rule and apply the forces of the material world must know the needs and wishes of the human family. The sage is now the man of the court, and instead of being secluded in his cavern on the mountain-side, he is at the right hand of the king. Once he gathered a few followers about him beneath the shadows of the silent pyramids to listen for the fancied music of the spheres; but now in massive walls he chains the thunderbolts of heaven and guides them in obedience to his will.

Here is a glorious transformation. To utilize and preserve these silent forces that are concealed about us, to govern, as deputies of the Creator, these phenomena with which he has clothed his power, to provide not merely comfort, convenience, and luxury to our human race, but perhaps in some of the contingencies that might easily arise even in this secure planet, essentially to preserve it and the possibilities of its existence: this is the vocation of the man of science. He is the herald of the world's progress; he is to mark the time of the centuries to [illegible]

[illegible] the world realize its debt to science? Imagine that we [illegible] no railroads, no steamships, no telegraphic lines; no [illegible] of commerce, no streets, buildings, reservoirs, [illegible] none of any of these great works of the con- [illegible] of humanity, works as eloquent in their silence as [illegible] in their vastness. Where would be our boasted civilization? How would our proud culture and altruism

be possible? These things have resulted from the opportunities afforded by the work of the engineer. He is the creator of this finished civilization; he is the Prometheus who has snatched a spark of divine fire for the eternal blessing of his race, and to him are due the thanks and honors which an enriched and glorified world may give.

How often, as we cross the teeming river, or dart into the crowded city, do we see the innumerable jets of steam that show white against the sky for an instant and then are dissipated into the atmosphere, never thinking that *there* is the badge of industry and the certain sign of human activity? Every one of those evanescent clouds of released steam is a witness to the concentrated thought and evolution of ideas that began with James Watt or Hero of Alexandria, as you please, and have continued till the present day among known or unknown followers of our great profession.

Such tributes as these are the silent eulogies of the illustrious dead who have toiled in that high vocation. Once the world persecuted its philosophers; now it all but worships them. Galileo was forced to bow to an ecclesiastical mandate and to bend his convictions to suit the mistaken ideas of clerical dignitaries; to-day his theories would have been first subjected to a scrutiny and criticism more severe than he or his age could have dreamed of, and then adopted, developed, and perfected, while he himself would have been crowned as a pioneer of truth. The rack and the wheel were once the unpleasant anticipation of him who sought to proclaim a new law of nature; but now the only rack he need fear is that of public opinion, while the fickle wheel of Fortune is that one which is to him of supreme interest. On all hands, the public, the press, the State, and even the Church, are welcoming and applauding the achievements of men of science. Hundreds of widely circulating magazines publish their discoveries; scores of meetings are held every month to discuss their conclusions; and as science has become more methodical, more systematized, and more in touch with the affairs and events of common life, the possibilities of harmony between it and these other forces grow to be more and more probabilities, certainties, actualities.

State and national governments offer prizes and endow institutions of learning; the Church is an ardent and sympathetic auditor; and both are ready to yield to Science her domain, while they still retain their own, and to say to the devotees of learning, in the language of President Patton: "We know, but then, we know in part; you know in part, but then, *you know*." And the Mechanical Engineer is the most complete representative of this modern science. We can not, and do not, and would not call ourselves such engineers; we have been simply given the passport that admits us to this land of promise; and it remains with us to do it honor.

Such are our reasons for pride at this long-expected hour. We envy no one, no matter how fortunate, for we believe that in no profession are there more golden opportunities for all than in ours. Success will be slow in coming, and, for many of us, success may never come. It cannot reach all of us. Just as in our student life there has been a gradation of merit and ability from the high to the low, there will be a range of ability and achievement. Now we stand upon an equal footing; we are "at the scratch," as the runners would say, waiting for the signal for the beginning of the race. Every nerve is strained; every muscle is tense. If we are handicapped, we have only ourselves to blame. Our training has depended largely upon ourselves, and now we shall see the difference between honest, patient, unassertive ability and that which is mere shallowness, showiness, and pretence. Perhaps some of those whom we have least suspected of being leaders will now forge ahead. The struggle that is to come will be a real one; the contest for supremacy will be close and keen, and new-comers will seek to outstrip us as we strive to overtake those who have entered the race before us. The sluggards will be thrust aside. The pretenders will be debarred. But for him who has made use of his student days of training, and who possesses the spirit and capacity of self-development to such an extent that he will seek to keep abreast of the thought and work of the age; for him who scorns as unworthy all but genuine work, all results not obtained by patient, persistent effort; who accepts no truth that is not altogether true; in short, for him who has inherited something of the spirit of such immortals as a Kepler, a

Newton, a Faraday, there *is* a future that may be bright to him, and glorious in the sight of the world.

In the face of such high anticipations, the actual realities of the morrow cannot but seem in sharp and painful contrast. For each one of us, there must come the dull routine, the daily drudgery, of the shop, the field, the office, to give us that capacity for concentration, that attention to business details, that acquaintance with commercial methods and habits, of which, in spite of our boasted practical training, we shall find we know but little. Bending over the drawing board or desk, the possibilities of the realization of these aspirations toward the intellectual work of engineering will seem vague and distant indeed. Yet let us not seek to avoid this training; we have acquired one sort of mental development; and have incidentally learned a few interesting and possibly valuable facts; but there is before us a school whose curriculum is as broad as human thought; whose course extends through human life; and whose diploma is the wisdom of human experience. Before we can graduate from *this* school, or before we can even ascend to the higher classes, we must go through the preliminary work of early years, the Freshman class of life, which after the constant variety and change of our college days will be more difficult to accomplish patiently than we now think. We cannot object to this, for it alone can make of us men of worth in the profession, while without it our highest usefulness would be in the capacity of ballast.

That ancient patriarch who was called to be the leader of the children of Israel was reared amid the mysteries and grandeurs of an Egyptian court. Separated, by a strange combination of circumstances, from his own people, he passed his youth in those shadowy temple-palaces whose ruins strike awe to the soul of him who may behold them, even to this day. There the young Semite imbibed the learning of the oldest nation of history. He pored over the marvelous wisdom of Phtah Hotep, of Trismegistus, of the Thaumaturgists, and gathered from the treasures of time the fruits of an almost prehistoric learning in perfect freedom and power. Reputed to be the grandson of a Pharaoh who was worshipped as a God, he held in the court the proud position of a prince of the royal blood, and before him were the possibilities of

glory and triumph in the fields of priest-craft, literature, or arms, as he might choose, with deification and immortalization in the hearts of the people as the proud consummation of his career.

But these things did not tempt him. Forsaking the allurements of triumphs so easily to be gained, he relinquished all hope of their attainment. He retired to the desert. For forty years he lived the humble life of an Oriental shepherd, guiding his flock over the rocks and ridges of Horeb; and in those days and years receiving a higher wisdom, attaining a deeper development, and growing to be more of a man and a character than would have been possible to him amid the refinements and opportunities of the royal court.

And the result? Prepared by these two score years of a new and necessary training, he assumed, under Divine direction, the sole leadership of three millions of slaves: He struck the shackles from their limbs; he united them; he led them through trackless wildernesses; found for them food and shelter; developed in them the ability to protect themselves against the fierce nomads of the desert; instituted among them a purer form of religious worship than the world had known; gave them a code of moral and civil and even of sanitary, law, that has never been surpassed; and made of them a mighty nation whose power and influence is felt to-day in every rise and fall of the stocks and securities of exchange, and is as great in this age of their dispersion and separation as it was in the palmiest days of the empire of Solomon.

How fortunate that this princely young student was not content with the future and fame even of an Egyptian priest-king, to occupy upon the page of History the space of a name! How wisely he chose in submitting to the drudgery of the desert, if *that* were destined to make him such a leader!

We have been given the training of a court. *We* have been surrounded with the most perfect of appliances and methods, and have received of wisdom almost from its source. And now, *we* are called to the humble preparation, here and there in this busy world, on the rock-ribbed hillsides or in valleys swelling with ores and oils, or in the midst of the steam jets and furnaces of the city: the preparation which will make us, too, qualified, to a

greater or less degree, to become leaders, and organizers, and directors, among men and their industries. May *we* be as patient as the leader of old! May *we* as unselfishly devote our efforts, our energies, our knowledge, and our lives, if need be, to our places of trust! And may we attain to *something* of that royal success with which the spirit of Clio has crowned his majestic head! Let us never forget our motto—the motto of our College —"Ad astra per aspera"—"to the stars through difficulties."

Yet, while we speak in such anticipation, there remains also something to be said in acknowledgement of what has been accomplished. I should in no degree fulfil my duty and trust were I to leave unsaid what in all sincerity I may say, in behalf of my class, to those leaders who have brought us to the triumph of this night.

Mr. President:

When we think of our Alma Mater, when we recall her proud history, and realize the standing which she has attained because of that history, we cannot but think of the guiding hand which has so largely contributed to make her present position and prestige possible. As we speak of the Institute, we must speak of its President, who, in the highest of duties and opportunities, still is proud to identify himself with our college.

We have found in you all the elements of leadership; and we would not let pass this, our last opportunity, of expressing to you how your personality has won for the institution which you represent our warmest loyalty. We begin now to realize the responsibility connected with such an office as yours; the constant control that is necessary over men and the affairs of men; the many calls of duty that devolve upon the incumbent, some because of the position, many because of the personality; but our observations have shown us the thoughtful, clear-sighted, conservative, yet discerningly progressive central figure, who has been as rigid and unflinching in his requirements from us and from himself as he has been influential and magnetic in winning from us that impulsive, hearty, and thorough allegiance which is more than mere servile obedience. [*Applause.*]

As in after life, we may indulge in reminiscences of our college days, we shall associate many influences in our memories; but

the centre and soul of those influences will be, Mr. President, none but yourself. Our thanks to you now would mean but little, for neither you nor we can as yet see the results of your work ; but in future years, the gratitude and reverence of honored, respected and successful engineers will be an abundant tribute for your efforts, and will be for your exertions on their behalf, the highest prize. [*Loud and continued applause.*]

Gentlemen of the Faculty :

This is a familiar scene to you. Year after year you have witnessed from this platform just such spectacles as this. Partakers in this distinctive ceremonial of student life, you have heard the same plaudits, you have submitted to the same eulogies ; and, as the representative of another graduating class speaks to you in its behalf, you experience no novel emotion, and know no unfamiliar sentiment.

But for us, this is not such an accustomed scene. This is our first, our last, our only Commencement. The emotions that stir us are fresh and genuine ; and if the language in which we seek to express them is hackneyed, puerile, and trite, it is not because there is in them any lack of sincerity, but rather because there is not in us the vocabulary that could alone do justice to such an occasion. You have made of us engineers ; but you have not attemped to make of us poets ; and we tender you our respectful but hearty thanks for that. [*Laughter and applause.*]

If you would understand the feelings which animate us tonight, you should not seek to remember these many Commencements which you have witnessed, so much alike, so lacking in novelty and point, but each one of you should rather recall that one Commencement which to him was more than all others ; that which was his own day of triumph ; that of which he formed a part. If across the vista of the years that have rolled away you can summon to memory a night when you stood in such a position as ours, you will need no prompting to suggest to you what our feelings are. We are ready now to ascribe to you with all the gratitude of which we are capable, respect and honor for your devotion to duty. We here cease forever the petty criticisms, the "grinds" and "drives" of student life, which we

and you as well, no doubt, have so thoroughly enjoyed [*laughter*]; and at this eleventh hour would make manifest to you that spirit and enthusiasm with and for you and for your work, which have always been deeply grounded in our hearts.

Each one of you has been an enthusiast in his own field of service, and each one of us has imbibed something of the enthusiasm which animates some one of your number. In contact with the energy and thoroughness which you have shown in your work, we have been enkindled with the desire to follow your footsteps in science.

But you have given us more than the mere knowledge of text-book and experiment. As you have stood before us so many times to speak of the things which you knew so well, we have studied the man as we have traced the reasoning of the professor; and what you are has overshadowed what you have taught, for what you have taught can at best be only a result of what you are.

Often you have stood to speak while we have been compelled to sit and listen; but now the parts are reversed, and it is our opportunity to speak to you, while you must, perforce, listen to whatever we may choose to say. [*Laughter and applause.*]

In our selection of favorites, not one of your number would be without a vote. [*Laughter.*] Each student swears allegiance to some pet professor as he specializes in some pet subject; but we agree and unite in ascribing to you all the tribute due to a body of such conscientious, high-minded, and scholarly gentlemen as you have shown yourselves to be. You have instilled into us somewhat of your own lofty ideals of service, and your highest thanks will be to see those ideals made real in our lives.

That thanks it will be our aim to give you; and as we part from you with your best efforts and wishes to inspire us, we can only return them by expressing the hope that you may see the fruitage of your labors in even greater abundance in the future than you have in the past. May such a prospect and such a reality be your well-earned reward, and may they encourage and inspire you in the noble work of education in which you are engaged—these are the parting wishes of the twenty-fifth class which you have graduated. [*Applause.*]

Classmates :

As I have spoken in your behalf, I have tried to voice the feelings which are common to us all, and to make my words mirror your thoughts. The task has not seemed difficult, for he who speaks with sincerity of the sentiments which are his own, must necessarily in some degree reflect the thought of all, when all are as united in spirit and position and purpose as we are to-night.

But there were many things of which I might have spoken, which even these kind and sympathetic friends could not understand. We know how much this class has meant to us; how it has called forth our loyalty and stimulated our patriotism as nothing has ever done before; and how we have endeavored, as wisely as we knew, to promote her interests. And now, all the flags must be rolled away, and all the banners furled, and our proud and royal Ninety-Seven become a relic of the past. Henceforth, we shall be known as Stevens men, without distinction of class. All of our allegiance, all of our loyalty, must now be transferred from the gray and the red of ninety-seven to the red and the gray of the college. She is our mother: and her let no man venture to assail.

Nearly four years ago, one hundred and twelve of us were on the roll-call, to begin the struggle which is to-night completed by sixty survivors. The rest have fallen by the way. [*Laughter.*] Though over the green hills of the past there rises no white shaft that marks a grave, and the icy finger of Death has never sent his shudder down our ranks, we return a mere remnant from the conflict. Here we have mustered for the last, the very last time, to respond to the final roll-call, and to receive our honorable discharge from the four years' service.

We have fought the fight together: we have conquered again and again, and now there remain only the parting words which must be said. We have known the eager rivalries and competitions of student life; there has been heard the clash of arms in many a knightly tournament: but there have been the knightly spirit, the honor of chivalry, throughout, and as we lay down our armor, it is with the greater respect for one another's prowess, and with the additional strength and self-confidence which come from such hard-fought contests.

We have known friendship: these years have been years of testing and sifting, until now we have chosen, and know, and trust, such friends as we shall never find again: and these intimacies will be most potent factors of our lives, for they will not be broken as our class and college life may cease, but they will be the one most priceless inheritance which our college days have left us.

To-night, we are a united class; united as we have never been before, and as we shall never be again. To-morrow, we shall be here, there, and everywhere, and soon this union, this class, these classmates, will be as things forgotten. We may look forward to many a reunion in future years; but as we exchange this, our last look, it is more than possible that our eyes may rest upon some whom we shall never see again. We must realize and accept the fact, which seems so unreal, that it is all over; that we have come to the parting of the ways; that henceforth our lives must diverge.

What shall I say to you, then? I may wish you success: I do wish you success; but I hope for you more than that. Above success and fame I place the satisfaction and recompense of genuine merit and manly integrity. May these be your heritage! And oh, my classmates, no word of mine can add to the good fortune, the prosperity, which I would, might be showered upon you; but as in this final moment of fellowship and reconciliation and union, I voice the silent and everlasting farewell of the class of '97, I invoke a gracious Providence richly to add to your knowledge and ability; to develop in you the deepest and highest of character and truth; to smile with sunny skies upon your pathways; to ward from over your heads the clouds of sorrow and misfortune; to lighten your days with all of joy and happiness and peace: and thus to crown the labors of your lives with grand, glorious, immortal success! [*Prolonged applause.*]

Selections from the "Geisha" were rendered by the orchestra, after which the Rev. Archdeacon Jenvey pronounced the benediction. After the exercises many visited the Institute which was thrown open for inspection. The machinery was in operation and several interesting experiments were in progress for the edification of the guests.

A list of the graduates and their theses is given :

HAROLD W. ANDERSON — JOSEPH M. TOWNE

Investigation of Speed and Power of Paddle-Wheel Steamer "Priscilla," Fall River Line

A. BALDASANO — WILLARD J. BEACH

Commercial Test of Coal and Study of the Effect of Forced Draft on the Economy of a Boiler at the Station of the Edison Electric Illuminating Company, New York

F. O. BALL — GORDON L. HUTCHINS

Efficiency Test of a 75 Kilo-Watt Direct Connected Unit

A. BEUTLER — P. J. BRUNE — T. J. MAIN

Test of Rife Hydraulic Ram

DONALD CAMPBELL — JAMES F. HUNTER

Test of Ammonia Absorption Refrigeration Machine of 50 tons Capacity for Capacity and Output

WARREN W. CHAPIN — CHARLES R. CHRISTY — WALTER KIDDE

A Study of Air Compression

JACOB E. CROMWELL — WARREN DAVEY — EDWIN R. KNAPP

Review of Essex Co. Electric Light and Power Plant, Orange, N. J.

ROGER CHEW — EDGAR T. POWERS — ALEXANDER B. MACBETH

Test of Steam Plant of the Richmond Locomotive Works

WILLIAM DARBEE — F. D. DATES — WILLIAM G. DOUGHTY

Balance of Heat in a Test of Two Vertical Tubular Boilers

LOUIS ELLEAU — WILLIAM D. ENNIS

Specific Heat of Liquid Ammonia

CHARLES B. GRADY — LEON B. LENT — WILLIAM A. KIRKLAND

Comparison of Results of the Determination of Heat in Coal by Analyzing the Coal, Burning in Mahler's Calorimeter, and Burning in a Boiler

W. S. HANDFORTH

Test of Ammonia Absorption Refrigerating Machine

CHARLES M. P. HIDDEN — OLAF M. KELLY

Insulation Measurements with High Potential

FRANK A. KOCH, JR. — A. E. WEICHERT

A Comparison of the Methods for the Determination of the Time of Setting of Portland Cement, by Means of the Viest Needle and the Gillmore Wires

PERCY LITCHFIELD — CONRAD L. MEISTER

Test of Corliss Engine and Determination of the Power Distributed to Different Manufactories, Brooklyn, N. Y.

WILBUR E. MALLALIEU H. C. MATHEY
Comparison Test, Condensing and Non-Condensing, of a 450 H-P Compound Tandem Buckeye Engine supplying Power for Electric Lighting

E. G. H. MEYER, JR. PAUL S. WHITMAN
Test of Worthington High Duty Pump, Hackensack Water Company, Union Hill, N. J.

A. B. MILLER A. DE LOS SMITH
Test of Ammonia Absorption Refrigeration Machine of 50 Tons Capacity, for Capacity and Output

CHARLES S. MOTT
Review of Refrigerating Machine

FREDERICK OPHULS W. I. THOMSON H. D. TIEMANN
Test of Nash Gas Engine and Riker Dynamo in Electrical Laboratory

A. M. ORR, JR. F. E. SCOTT H. S. MORTON
Trial of S. S. "Jamestown," Old Dominion Line, Including Economy Test of Engine and Boiler

R. L. MESSIMER
Test of Leavitt Air Compressor at Calumet, Michigan

FREDERICK L. PRYOR
Test of the Boiler and Engine of the Electric Light Plant of D., L. & W. R. R. at Hoboken

G. P. RICHARDSON J. A. WILLIAMSON
Test of Two "Columbia" Boilers

R. V. ROSE EDWARD O. STEINBRÜGGE, JR.
Comparison Test of High Pressure, High Speed Engine and Low Pressure, Low Speed Engine, Each 200 H-P, Running under same load and Driving a Dynamo

FRANCIS H. SAWYER THOMAS L. TERRY JOHN VAN BRUNT
Efficiency Test of Direct Connected Dynamo at Produce Exchange, New York City

EDWARD C. WARREN G. D. WILLIAMSON
Cost of Elevating and Conveying Coal from Barges to the Bins of American Sugar Refining Co., in Jersey City, N. J.

EVERETT N. WOOD HENRY T. WOOLSON
Test of Nash Engine and Determination of Conditions for Maximum Efficiency

ALUMNI MEETING.

The twenty-first annual meeting of the Alumni Association was held on Tuesday evening, June 15, in the Lecture Hall of the Stevens School.

In the absence of both the President and the First Vice-President, Mr. R. M. Dixon, '81, the Second Vice-President, called the meeting to order and presided. The Recording Secretary being also absent, Mr. F. DeR. Furman, the Corresponding Secretary, was called upon to take his place.

The minutes of the last meeting of the Association were submitted as printed in the INDICATOR, as also were the proceedings of the Executive Committee for the entire year excepting for the last meeting, held June 2, at the office of Mr. F. E. Idell, 26 Cortlandt Street, New York City. The minutes for the latter meeting were read as follows:

The meeting was called to order by Mr. R. M. Dixon, Second Vice-President. In the absence of the Recording Secretary, Mr. F. DeR. Furman was appointed, *pro tem.*

Applications for membership in the Alumni Association were received from the following members of the class of '97, all of whom were elected as Associate Members, but to become Active Members without further notice as soon as they shall have received their Degree, in accordance with the provisions of the Constitution:

Harold W. Anderson,
Arthur Baldasano, Jr.,
F. O. Ball,
Donald Campbell,
C. R. Christy, Jr.,
Jacob E. Cromwell,
William Darbee,
F. D. Dates,
Warren Davey,
William F. Doughty,
Louis A. Ellan,
Charles B. Grady,
Ernest H. Meyer,
Arthur B. Miller,
Henry Samuel Morton,
C. S. Mott,
Fred Ophüls,
A. Macklin Orr, Jr.,
Frederick L. Pryor,
George P. Richardson,
Rudolf V. Rose,
F. Hudson Sawyer,
Fred E. Scott,
A. DeLos Smith,

Charles P. Hidden.
James F. Hunter.
Gordon L. Hutchins.
Olaf M. Kelly.
Walter Kidde.
William A. Kirkland.
Edwin R. Knapp.
Frank A. Koch.
Leon B. Lent.
W. E. Mallalieu.
Henry C. Mathey.
Conrad L. Meister.
Robert L. Messimer.
Edward Steinbrugge, Jr.,
Thomas L. Terry.
William I. Thompson.
H. Donald Tiemann.
Joseph M. Towne.
John Van Brunt.
Edward C. Warren.
Arnold E. Weichert.
Paul S. Whitman.
G. D. Williamson.
J. Abeel Williamson.
Everett N. Wood.
Harry T. Woolson.

It was decided to hold the annual meeting of the Alumni Association Tuesday evening, June 15, at 8 o'clock, in the Lecture Hall of the Stevens School.

It was regularly moved, seconded, and carried that the balance of the Library Fund be applied to completing the file of the *Philosophical Transactions of the Royal Society of London* as far as possible.

The ballots for officers of the Alumni Association for the ensuing year were canvassed with the following result :

PRESIDENT.

John W. Lieb, Jr., '80 .... 119 votes
Edwin Tatham, '81 .... 30 "

FIRST VICE-PRESIDENT.

Robert M. Dixon, '81 .... 113 "
Edwin Burhorn, '85 .... 34 "

SECOND VICE-PRESIDENT.

Hosea Webster, '82. .... 99 "
William B. Yereance, '88 .... 45 "

CORRESPONDING SECRETARY.

Franklin DeR. Furman, '93 .... 140 "

RECORDING SECRETARY.

Gordon Campbell, '88 .... 83 "
John S. DeHart, Jr., '90 .... 64 "

TREASURER.

William H. Bristol, '84 .... 148 "

DIRECTORS.

Ernest H. Foster, '84	107 votes
William R. King, '86	75 "
Alten S. Miller, '88	62 "
William O. Ludlow, '92	48 "

ALUMNI TRUSTEE.

Lewis H. Nash, '77	74 "
Edward P. Roberts, '77	45 "
Frank C. Jones, '78	13 "

Those present at the meeting were: F. E. Idell, E. A. Uehling, P. E. Raqué, R. M. Dixon, A. Riesenberger, W. H. Bristol, and F. DeR. Furman.

At the conclusion of the Secretary's report the minutes as printed in the INDICATOR, and as read, were accepted.

The Treasurer, Prof. W. H. Bristol, '84, was then called upon and reported as follows:

TREASURER'S REPORT.

HOBOKEN, June 1, 1897.

To the Alumni Association of the Stevens Institute of Technology:

I.—GENERAL FUND.

Receipts.

Balance in Fund June 17, 1896	$272.92	
Dues 1896 97	877.50	
Dues for arrears	100.00	
Dues in advance	10.50	
	——	$1,260.92

Expenditures.

Alumni subscriptions to STEVENS INDICATOR to June, 1897	$732.38	
F. DeR. Furman, Corresponding Secretary, printing, postage, and clerk hire	101.23	
W. H. Bristol, Treasurer, postage	28.50	
H. F. Raetz, addressing envelopes	1.50	
R. M. Dixon, Treas. 25th Anniversary Com., for subscription to expenses of reception	150.00	
Expenses annual meeting, June 17, 1896	4.00	
	——	$1,017.61

Balance on hand June 1, 1897	$243.31

II.—Beneficiary Fund.

Receipts.

Balance on hand June 17, 1896	$379.78	
On loans repaid	72.50	
Interest on loan	5.62	
Bank interest to Jan. 1, 1897	10.01	
		$467.91

Expenditures.

Loan	$ 50.00	
Loan	150.00	
		$200.00
Balance on hand June 1, 1897		$267.91
Amount of outstanding loans, including temporary loan of $600 to Stevens Indicator		$1,319.73

III.—Library Fund.

Balance in fund June 17, 1896	$119.34	
Bank interest to Jan. 1, 1897	4.59	
Balance on hand June 1, 1897		$123.93

IV.—Library Portrait Fund.

Balance in fund June 17, 1896	$1.72
Balance in fund June 1, 1897	1.72

V.—Stevens Indicator.

Receipts.

Balance on hand June 17, 1896	$312.44	
From Prof. Riesenberger, Business Manager	696.78	
From Prof. Furman, Business Manager	30.25	
Alumni subscriptions to date	732.38	
		$1,771.85

Expenditures.

Publication July Indicator, 1896	$379.35	
" October " 1896	316.50	
" January " 1897	294.19	
" April " 1897	309.35	
Prof. Riesenberger, editing July, October, January and April Indicators	100.00	
Prof. Stillman, editing July, October, January and April Indicators	100.00	
Stationery and printing	15.87	
Electros, cuts and photographs	97.49	
Envelopes for mailing Indicators	17.63	
		$1,630.38
Balance on hand June 1, 1897		$141.47

Respectfully submitted,

W. H. Bristol, Treasurer.

On motion, the Treasurer's report was accepted.

The customary report from the retiring Alumni Trustee, Mr. Frank E. Idell, Jr., '77, was called for, but as he had been unavoidably detained, Mr. Alexander C. Humphreys, '81, of the Board of Trustees, gave an informal report announcing the election of the new Alumni Trustee.. Mr. Idell arrived later and submitted the following report:

Mr. President and Members of the Alumni Association.

As the retiring Alumni Trustee, I have to present a short report of the condition of the Institute during the past year.

About as many students attended the College during this year as during the year previous, with fair prospects of having a large class enter next fall.

The graduating class this year is not as large as that of last year. Their training has been thorough, and they are now fully prepared to take up their professional work on a larger scale with every confidence of ultimate success.

The Institute has suffered somewhat from the hard times; the financial report of the Board of Trustees for the year showing a slight deficit.

The endowment fund of the Institute is not large and it requires very judicious handling to make the total income meet the expenses.

It is hoped that each alumnus will continually bear in mind the needs of the Institute and will do all he can to interest his friends in the College and to advocate it as the best place to send young men to study mechanical engineering. The number of technical schools is increasing and we must look alive if we are to have our fair proportion of students. The high standing of the Institute is to be maintained, and this, with the earnest and persistent work of our graduates and friends must be relied upon to attract students to Stevens.

During the past year we celebrated our 25th anniversary, Those of you who were able to be present at the celebration know what a great success it was both in the numbers present and in the enthusiasm awakened. If the spirit of the celebration will continue to abide with us, then the success of the Institute is assured for all time.

You also know of the generous gifts of $30,000 to the Endowment Fund made by Mrs. Edwin A. Stevens and of $10,000 to the Building Fund made by President Morton. We recognize in these gifts the deep and continuing interest of the donors in the welfare of our Alma Mater.

The exhibition of work done by our graduates calls for the highest praise and it is safe to say that no technical school of the same or greater number of years standing can show such an amount of excellent original work : The Institute is proud of its graduates and the graduates, I know, are proud of the Institute.

As an outcome of this exhibition, a permanent exhibition of work done by the graduates has been started—many of the exhibitors having presented their apparatus to the Institute for this purpose, and as this exhibition grows, it will prove an incentive to greater efforts, not only to the undergraduates but to the Alumni as well.

During the past year the Trustees provided a course of lectures on "Patent Law" and "Business Methods."

These lectures were well attended but deserved a much larger attendance on account of the importance of the subjects treated. A similar course of lectures will be given during the coming year, and it is expected that one of them will be devoted to the subject of the "Commercial side of Engineering problems," so as to show the student the necessity of considering the dollar side of the question when at work on original designs of machines, manufacturing and power plants.

I regret very much, to state that the continued illness of Prof. Mayer may necessitate his withdrawal from active duty but it is hoped that it will not be necessary for him to sever entirely his connection with the Institute for which he has done so much.

I now have the pleasure to announce that, at the meeting of the Trustees held last evening, Mr. L. H. Nash, '77, was elected Alumni Trustee for a term of three years.

In concluding I would thank you for the honor which you have conferred upon me in having made me one of your representatives upon the Board of Trustees, and which honor I now resign into the hands of an able and efficient successor.

Respectfully submitted, F. E. IDELL.

The Trustees of the Alumni Building Fund then reported as follows:

JUNE 15, 1897.

To the Members of the Stevens Institute Alumni Association.

GENTLEMEN: The condition of the Alumni Building Fund at this date is as follows:

Amount received from all sources to June 15, 1897	$25,366.38
Amount in Fund June 1, 1896	13,400.81
Increase for year	$11,965.57
Paid rental for box in safe deposit vault	6.00
Net increase for year	$11,959.57

The receipts during the past year have come from the following sources:

Interest on $20,000 bonds (contribution of President Morton)	$ 950.00
Interest on invested funds	623.07
Subscriptions paid	257.50
New Contributions:	
Pres't Morton, 1,000 shares Texas & Pacific R.R. stock, present value	$10,000.00
A. R. Wolff, '76	25.00
A. G. Glasgow, '85	100.00
Wm. T. Magruder, '81	10.00
Total	$11,965.57
Total amount in Fund, including interest to June 15, 1897	$26,448.17

Respectfully submitted,

HENRY MORTON,
A. RIESENBERGER,
Trustees of Fund.

Upon motion, this report was accepted.

In response to an invitation from the chairman for a statement from the Committee in Charge of the Twenty-fifth Anniversary of the Institute, Mr. Alexander C. Humphreys said that the committee had been most agreeably surprised at the interest shown by the members of the Association and the large number present at the banquet at the Waldorf. He also spoke of college spirit met in all quarters and of the good effect produced.

The following applications for membership to the Associa-

tion were received. All were from members of the class of '97 and were elected: Willard J. Beach, A. Beutler, Jr., P. J. Brune, Percy Litchfield, and Thomas J. Main. In this connection it was explained that this year a departure had been made from the usual custom of electing the graduating class *en masse* without first ascertaining from all the members their willingness to join the Association. This year, application cards were printed and distributed, together with a copy of the Constitution of the Alumni Association, to each member of the graduating class, fifty of whom applied for admission and were elected by the Executive Committee in advance of the general meeting. The five applications mentioned above were received too late for the Executive Committee to act upon.

The result of the election of officers, Directors and Alumni Trustees, all of whom will constitute the Executive Committee for the ensuing year, was submitted, as follows:

PRESIDENT.

John W. Lieb, Jr., '80.

FIRST VICE-PRESIDENT.

Robert M. Dixon, '81.

SECOND VICE-PRESIDENT.

Hosea Webster, '82.

CORRESPONDING SECRETARY.

Franklin DeR. Furman, '93.

RECORDING SECRETARY.

Gordon Campbell, '88.

TREASURER.

William H. Bristol, '84.

DIRECTORS.

Edward A. Uehling, '77, and Philip E. Raqué, '76, hold over; Ernest H. Foster, '84, and William R. King, '86, elected.

ALUMNI TRUSTEES.

George M. Bond, '80, and Harry de B. Parsons, '84, hold over; Lewis H. Nash, '77, elected.

President E. P. Roberts of the Association, who had expected to be present up to the last minute, sent a letter, from which the following is an extract: "I have been looking forward to this meeting ever since I was honored with the Presidency of the

Association, and, although rejoicing that it was my privilege to be present at the twenty-fifth anniversary of Stevens, nevertheless, in some respects, I desired even more to be present at the meeting about to take place. . . . I forward my address, regretting that I cannot deliver it in person." The address was read by the acting Secretary, and is as follows:

THE MECHANICAL ENGINEER AS A CITIZEN.

The statement that every man should be a good citizen is one in which all are willing to acquiesce, although there are comparatively few who make it a principle of action. There are certain general duties as a citizen which every man should perform, and in addition thereto, each man should do that special work for which he is best fitted. Any problem in social economy affects all, but there is one problem of special interest to the Mechanical Engineer, and which he is especially well fitted to study, discuss, and report upon, and the result of his investigations should prove of benefit to the community. It is what is sometimes termed "The Relation of Capital to Labor" and also "The Conflict between Labor and Capital."

It is not intended in this address to offer any solution to the problem, but to point out why, in the speaker's opinion, the Mechanical Engineer is especially fitted to assist in its consideration.

In the first place, is there a problem to be solved? Secondly, is there a "*conflict*" between Labor and Capital? Granting, for the present, that there is a problem, let us consider whether the relation of labor to capital is a "conflict." It seems to me that it is, and necessarily so, and I submit the following propositions in proof of the correctness of the statement.

Any investigation should aid to discover facts; a theory may be formulated afterward. The question is not "*What should be*," but what *are* the facts.

1st. Every man desires as large a return from his investment as he can obtain.

2d. The capital of the wealthy man is money, or its equivalent; the capital of the brain worker is his knowledge; the capital of the skilled artisan is his skill; and the capital of the unskilled laborer is his physical strength. All are various forms

of capital, and a man may possess more than one form. Money capital is, however, differentiated from other forms of capital in certain respects, and is what is generally termed "*Capital.*"

3d. If the foregoing is a statement of facts, there must be a conflict between all forms of capital; not only conflict between capitalists of different classes, but between those of the same class. It is only by avoiding competition that there can be no conflict between those of the same class, but the conflict will still exist between those of different classes.

4th. It is to overcome and prevent competition that Trusts and Labor Unions are formed, both being "Unions." This certainly is the case for "Trusts," and is the distinctive feature of Labor Organizations, differentiating them from Mutual Aid Societies of other kinds, such as the Turners Associations, or other associations having educational, insurance, and other benefits.

5th. "In union there is strength."

6th. The strength is exerted for the benefit of those in the Union, and may, or may not, be detrimental to all outside of the Union, but is, in its very nature, opposed to those with whom it is in conflict.

7th. To equally benefit all, all must belong to the union, without limitations as to city, state or continent; but this necessitates the millenium, and something less perfect will be the working conditions.

8th. Large capital is necessary to carry out great industrial enterprises, and every indication points to the increase of "Combinations of Capital."

9th. Labor Unions are also increasing in strength, and evidently will continue to grow.

10th. Trusts and Labor Unions have been both beneficial and injurious to the community at large, and it is the aim of the State Government to so control as to prevent any exercise of power by one to the injury of another, whilst giving to each the largest personal liberty, and, therefore, it is the duty of the State to investigate whatever seems to be a menace to the rights of any of its citizens, and formulate and introduce rules for the regulation of any evil which is found to exist, or appears to be imminent.

Having presented the foregoing propositions for consideration, let us consider the special conflict between the capital of money and the capital of physical force, either skilled or unskilled, this being the conflict generally meant by the phrase, "The Conflict between Capital and Labor," digressing long enough to state that the brain worker is not only "in the fight," but generally "between two fires"; and also that the exerter of physical force is not the only workman, or laborer.

Let us briefly consider the growth of manufacturing establishments. In the earlier portion of the century, manufacturing was largely manual labor, and carried on in small shops or at the home of the owner. The skilled workmen were graduated apprentices of the proprietor, and the unskilled were apprentices who were practically members of his family, and all were, to a great extent, on the same social plane. Later, the shops increased in size, but the men were still known to the proprietor, not only by name, but by character, and individual effort for good, or bad, came directly under his eye.

At the present time, manufacturing is largely carried on by corporations. The Board of Directors meet; possibly the times are bad, or an energetic competitor has cut prices. The balance sheet is studied—the manager is notified that he *must* reduce cost. If he does not, he loses his position. He studies the situation; the labor item as well as the purchase of material must be cut. He notifies his subordinates. Shortly the cut reaches the "hands." They must either submit or "fight." It may be that the facts are that if a reduction is not made, the factory *must* close. If it close, the money capitalist loses possibly all his investment; the laborer loses, for a time, an opportunity to profitably invest his capital, and the necessities of the laborer cause him to accept a condition which is to the benefit of the capitalist. On the other hand, the "cut" may be ordered, not by actual necessity, but to "make a showing," in which case the laborer feels that he has a just grievance, and that there is not a just proportion of the profits being shared between capital and labor. This brings us to two questions—

1st. Should there be a division of the profits between capital and labor?

2d. What is a fair division?

Relative to the first consideration, many will argue that there is no basis in equity for the sharing of profits between capital and labor; that the facts are that the capitalist invests his money, and engages certain men to act as his assistants, and certain others to act as skilled and unskilled workmen; that he agrees to pay each one a fixed amount as long as he is in his employ, and that any employee has a right to stop work whenever he so desires (unless limitations have been made in the contract), and that the profits of the business depend entirely upon the manager's ability to create or fill a demand for his goods, and to fill such a demand at a price which will leave a profit. If the foregoing is correct, then "Profit Sharing" is not based on a principle of equity, but upon the principle that it is beneficial to the capitalist. This does not imply that it may not also be beneficial to the laborer, or that it should not be studied in its relation to each. A different form of "Profit Sharing" is what is known as "Co-operation." In "profit sharing" the capitalist generally retains entire control of the business, in other words, it is *his* business, and he decides that if his employees receive a certain proportion of the profits he will save in operating expenses something more than the amount which they receive; therefore, the question as to what is a proper division of the profits between capital and labor is not, necessarily, a factor in the decision as to the ratio of division. When, however, it is a matter of "Co-operation," the division of the profits and losses between capital and labor is one of the principal factors, and those interested in the organization of co-operative enterprises are not likely to find that there is any moral law which does, or should, control; because the risks and possible gains will be studied by the various investors—the investor of money, of brains to manage the business, and the laborer, skilled and unskilled, and what they are willing to agree upon depends entirely upon the special case. If in "Co-operation" there is no fixed law of division, how can there be when the conditions are those of private ownership?

Possibly certain of the foregoing statements, without reference to the context, would seem to indicate a belief on the part of

the speaker that [illegible] either Trusts or Labor [illegible] such a manner as they may [illegible] is not a fact [illegible] have a right to call upon the [illegible] should not be [illegible] extent [illegible] of their [illegible] not now [illegible] upon a large [illegible] present the [illegible] the statement that the Mechanical Engineer [illegible] particular is [illegible] Capital and Labor.

[illegible] a trained mind and it is [illegible] President Morton's ad- [illegible] the [illegible] After he has received such [illegible] the shops and [illegible] such time he should [illegible] should not only work with [illegible] in the shops [illegible] [illegible]

[illegible] the necessary [illegible] [illegible] my statement is proved

It is not supposed that any sudden change for the better would follow the putting into practice by all Stevens' graduates of the advice given or suggestions made in this address. If, however, Stevens' men would take hold of this matter, and each one would study the problem until he thinks he knows something about it, and then continue until he arrives at the conclusion that he knows very little about it, and then present what little he does know to the consideration of Labor Organizations, Boards of Trade, Engineering Societies, etc., STEVENS' men would be a factor, and not a small one, in the solution of one of the most important problems in social economy.

Doubtless some of the propositions which have been set forth in this address will not be accepted by some as statements of facts. For the purpose of the address, it makes no difference whether or not they be so accepted; what I desire is that every one should study the case for himself, and decide, not only upon the accuracy of the few statements I have presented, but upon the vast number of other questions which will confront him as he takes up the study of the problem. Not only Profit Sharing, Co-operation, Governmental Control, and some other matters which have been touched upon must be investigated, but arbitration enforced by the Government; arbitration as agreed upon for each issue after the issue has arisen between the contending parties; arbitration by a standing Board composed of members of each party; the piece rate system; the fixed daily wage; the sliding scale system; and other questions too numerous to mention will confront the investigator, and will require for consideration a knowledge of the various classes of men, and also of the history of the subject, the successes and failures, and, as far as can be discovered, the reasons which caused success or failure. It is an endless study, but it is worth unlimited effort.

All of us who attended the celebration of the twenty-fifth anniversary of Stevens not only had our hearts quickened with love for our Alma Mater, but threw back our shoulders and held up our heads with pride in being graduates of an institution which could show such a record as was manifested at that time. We have all heard many addresses as to the value of a Mechanical Engineer to the community. If he will take the position

which he should, as a professional man, he will be a power for good in the community at large, and those who meet to celebrate the fiftieth anniversary of Stevens will number not only those noted for their engineering attainments, but also those known far and wide, and not only noted, but loved and reverenced, for what they have done, either to lessen the hardships of the strife between capital and labor, or, if it be possible, for having shown both by precept and example how to form a Union which will embrace employer and employee, making them, not antagonists, but partners ready and willing to discuss and adjust all their differences.

Mr. Roberts' address was listened to with much interest, and was the subject of remark and commendation by several of the subsequent speakers. A vote of thanks was tendered Mr. Roberts for the interest he had taken in this matter.

President Morton was invited by the chairman to address the Association, which he did in his very characteristic and agreeable manner. His marked enthusiasm on all points touched, infused itself into the members present, who loudly applauded him at the conclusion of the following address:

Mr. President and Gentlemen of the Alumni Association:

I think I may regard it as an augury of good omen that we meet here to-night with the Silver Wedding of our Alma Mater behind us and her Golden Wedding before us, as an object to look forward to and prepare for.

What is more, we can look back upon our Silver Wedding and its commemoration with a large share of solid satisfaction.

I will admit that when on a like occasion last year I had the pleasure of addressing you, I entertained very serious misgivings as to whether it would be possible for us to carry off the ceremonies of our 25th anniversary in a manner worthy of the occasion and creditable to all concerned and these misgivings I know were shared by many of those to whose energy and self-sacrificing exertions the remarkable success of our celebration was substantially due.

But with the characteristic courage and determination to conquer fate which has had much to do with their success in life,

these gentlemen took hold of the enterprise in its various parts with the result of achieving such a phenomenal success as surprised even themselves and astonished every one else.

Where so many did well it is difficult to particularize but I cannot refrain from mentioning the debt we owe to Mr. Humphreys in the organization of the Banquet at the Waldorf, to Prof. Bristol for getting up the Exhibition in the Institute Building and to Mr. Wetzler for securing such preliminary and subsequent notices in the press as thousands of dollars could not have purchased.

In connection with the above I should be most ungrateful if I did not mention the energy and enthusiastic devotion displayed by a large number of our under-graduates who labored not only indefatigably but with great intelligence and skill, and not only all day but long into the nights, in arranging the exhibits and fitting up the various rooms for their reception and operation.

Nor should I forget the almost one hundred graduates who often, at large expense, rendered the success of this exhibition possible by the exhibits which they sent.

To all our thanks are justly due in no stinted measure, and they should be long and warmly remembered.

Among the many gratifying results of these Anniversary celebrations we may number the generous gift by Mrs. Stevens of houses and land which will add at once $1500 to the yearly income of the Institute and is likely in the coming years to largely appreciate.

Some time ago it was suggested that the Institute had not been properly advertised but I think that this can no longer be said with any show of reason.

The Sunday Supplement of the *New York Times* with its strikingly illustrated article, Professor Coleman Sellers' description of the Anniversary Celebration occupying the first page of the *London Engineering* for March 26th and the full notices which have appeared in all the American Engineering, Electrical and General Scientific Journals, constitute an output in which our Press Committee may well take pride, and which will carry the fame of the name of the Institute as our graduates have already carried its fame into every quarter of the globe.

The events of the last year have taught us the Engineering strength of our Alumni individually and collectively and have done more than anything before to bring our Graduates, Under-graduates and Professors into contact and sympathy and form links of union which we may hope will grow stronger as the years roll on.

In conclusion then let me say that whether I look backward on what has been accomplished or forward to that which we may reasonably hope to attain I see nothing but encouragement and fit subjects for congratulation.

The Chairman then called upon several of the professors and members present, among whom were:

Professor Kroeh, who spoke of the happy time enjoyed by all during the twenty-fifth anniversary celebrations, and also of President Morton's article in *The Cosmopolitan* on "Modern Education," dwelling especially on the thoughts suggested by the term, "liberal technical education," which was there used. Professor Kroeh did not lose the opportunity to speak of the Department of Languages at the Institute and to state, incidentally, that he was about to write several new text-books on modern languages, which brought forth an audible and concerted sigh from some of the younger members and laughter from others. To this

Dr. Geyer who was next called upon, responded that he was not guilty of writing text-books, which to him was a comforting assurance. Laughter. Dr. Geyer also took occasion to speak briefly of the part taken by the Department of Electricity in the twenty-fifth anniversary exhibition.

Mr William Kent, who followed, assumed that he had been called because of the fact that he was a member of the oldest class represented that evening, and, working on that assumption, added that he might belong to one of the oldest classes, but that he did not feel the oldest, by any means. He called serious attention to the address of Mr. Roberts, and declared that the labor problem is worthy of the attention of all minds, and that it can be solved only by a process of evolution, through which it is now passing, and the result of which no man can tell.

Mr. Gus C. Henning presented several thoughts that had occurred to him during the silver anniversary exhibition, stating that while the steam, gas, and electrical industries had been developed by our graduates, that of hydraulics was not in much evidence, which was a matter of regret. The mechanical construction of the articles exhibited, he averred, was of a high character and extremely creditable, showing unmistakable evidence of the valuable training received in the Physical Laboratory. Without exception, all of the mechanisms exhibited were noted for the accuracy and precision of results obtained, and that they showed a *real* advancement and improvement along engineering lines. Mr. Henning also said that the value of mathematics to the graduate engineer should not be underestimated on the ground that it is of little practical use, for, although it is not used in practice as a pure science, it is often of great advantage in taking "short cuts," which are based upon what is studied at Stevens.

Mr. E. A. Uehling also responded with a few remarks bearing upon President Roberts' address, in which he said that the engineering profession knows better than any other, both sides of the labor question, and in the solution of the problem which must come, the engineer must stand between the capitalist and the laborer.

Dr. Durand Woodman entertained the members with several stories in connection with his comments on the good purpose to which men of means could bestow at least a part of their fortune by remembering the Stevens Institute.

Mr. F. DeR. Furman, on part of the INDICATOR, invited the members of the Association to contribute articles of general interest on engineering topics; to send notices promptly of removal, change of occupation, *accomplishments*, *noteworthy or special work in hand*, or any news for the personal columns of the INDICATOR in which classmates or brother alumni might be interested. In case of modesty on the part of those who have accomplished or, those who are doing creditable work, as italicised, or in case the person or persons so engaged should underestimate their work, friends are invited to send notice of such work, and, although meagre, the information so received will be worked up, if possible,

by the editors. A large proportion of this matter is now obtained by review of the trade journals, and much is undoubtedly lost which, if brought together, would help materially to keep the work of Stevens graduates prominently before the public, and thus would the quarterly record of the work of our graduates redound to the honor and credit of Stevens. Members of the Association can also assist the management by returning the compliment paid to the INDICATOR by its advertising patrons, whenever articles in their lines are needed, and by always mentioning the STEVENS INDICATOR in any correspondence.

The meeting then adjourned.

It was the largest annual meeting in the history of the Association. Those present were:

President Morton,
Professor MacCord,
" Kroeh,
James M. Cremer, '76,
Gus C. Henning, '76,
William Kent, '76,
Adam Riesenberger, '76,
Alfred P. Trautwein, '76,
William E. Geyer, '77,
Frank E. Idell, '77,
Edward A. Uehling, '77,
Durand Woodman, '80,
Robert M. Dixon, '81,
Alex. C. Humphreys, '81,
Hosea Webster, '82,
William H. Bristol, '84,
Ernest H. Foster, '84,
David S. Jacobus, '84,
Edwin Burhorn, '85,
Charles E. Machold, '85,
William M. Stevens, '85,
Fred. N. Morton, '86,
Robert M. Anderson, '87,
Johannes H. Cuntz, '87,
Henry A. Bang, '88,
Richard Beyer, '88,
Gordon Campbell, '88,
N. St. George Campbell, '88,
George Dinkle, '88,
Paul Doty, '88,
Franklin DeR. Furman, '93,
Henry Kopp, '93,
Edward D. Lewis, '93,
George L. Wall, '93,
Edward P. Buffett, Jr., '94,
Charles C. Hartpence, '94,
Morris W. Kellogg, '94,
Charles W. MacCord, Jr., '94,
Gilbert Rosenbusch, '94,
Louis Ruprecht, '94,
Percy Allen, '95,
George E. Bruen, '95,
Albert F. Ganz, '95,
Robert E. Hall, '95,
Edward M. Harrison, Jr., '95,
Edmund Kemble, '95,
Charles P. Paulding, '95,
Edward W. Robinson, '95,
Charles J. Slipper, '95,
John P. Badenhausen, '95,
Harry T. Bernhard, '96,
William J. A. Boucher, '96,
Waldo E. Denton, '96.
Walter H. Dickerson, '96,
James B. Faulks, Jr., '96,
Celestino Garcia, '96,
Robert E. Leber, '96,
William H. MacGregor, '96,
Charles B. Peck, '96,
Leonard Seeligsberg, '96,

Edward Ducommun, '88,
John V. L. Pierson, '88,
Henry L. Ebson, '89,
Frederick J. Gubelman, '89,
William D. Hoxie, '89,
Robert C. Oliphant, '89,
George L. Todd, '90,
Henry Torrance, Jr., '90,
Lloyd H. Nettleton, '91,
Frederick Gardiner, '92,
Electus D. Litchfield, '92,
Herman Loewenherz, '92,
William O. Ludlow, '92,
Bancroft G. Braine, '93,
Max J. Weichert, '96,
Wallace Willett, '96,
Arthur J. Wood, '96,
Clifford G. Woolson, '96,
Donald Campbell, '97,
Jacob E. Cromwell, '97,
Charles P. Hidden, '97,
Olaf M. Kelly, '97,
Walter Kidde, '97,
Henry C. Mathey, '97,
Arthur B. Miller, '97,
C. S. Mott, '97,
Everett N. Wood, '97.

OBITUARY NOTICE.

ALFRED MARSHALL MAYER.

Professor Mayer died July 13th, after an illness of several months, at his home in Maplewood, N. J. He was in his 61st year.

At the time of Professor Mayer's death, this issue of the INDICATOR was in press. A full account of his life will appear in the October number

ANNOUNCEMENT BY THE UNITED STATES CIVIL SERVICE COMMISSION.

The following announcement was received from the U. S. Civil Service Commission, July 7, and is published with the thought that it might prove a desirable opportunity for some of the Alumni:

The U. S. Civil Service Commission announces a competitive examination for the purpose of establishing a register from which certification may be made to the position of Examiner, Mint Bureau, Treasury Department, at a salary of $2500 per annum.

The duties of the position comprise the inspection and supervision of all the machinery installed in different U. S. Mints throughout the country.

Applicants should be graduates of recognized technical schools giving courses in mechanical engineering, or should, in lieu of this, have very broad training and experience along the lines of mechanical engineering.

Competitors will be rated upon: (1) Their technical education, as shown by diplomas or certificates of graduation from recognized technical schools, or as shown by letters and testimonials from other reliable and trustworthy persons: (2) Their technical experience, as shown by their own statements with suitable references to reliable persons for corroboration: and, (3) On a thesis on the organization of the office and the administration of the duties of Examiner, Mint Bureau, Treasury Department.

Application blanks and the specific requirements of the examination, together with the forms on which the work is to be submitted, will be furnished upon request. The completed examination must be filed with the Commission not later than August 9, 1897. Address all communications to the U. S. Civil Service Commission, Washington, D. C.

INSTITUTE NOTES.

THE HONORARY DEGREE OF LL.D. was conferred upon President Morton by the Trustees of Princeton University at the 150th annual commencement exercises held June 16th in Alexander Hall, Princeton. This degree was conferred at the same time upon ex-President Cleveland, General John L. Cadwalader, Augustus St. Gaudens and Rev. Theodore L. Cuyler.

MR. ANDREW CARNEGIE, OF OUR BOARD OF TRUSTEES, was the subject of a very extensive biographical sketch in the May number of *Cassier's Magazine*. The sketch includes the frontispiece, which is an excellent likeness of Mr. Carnegie, and several illustrations, among which are his birthplace at Dunfermline, Scotland, and the Edgar Thompson Steel Works and Blast Furnaces, Bessemer, Pa. The story of the life of this most remarkable man is told in a very entertaining manner, and is indeed an inspiration for those who are ambitious.

HON. ALEXANDER T. MCGILL, ALSO OF OUR BOARD OF TRUSTEES, has just recovered from a long illness. Together with his family he sailed for Europe, July 3, where he expects to remain until September 1, at Devonshire, England.

Chancellor McGill was taken ill last February with a severe attack of "grippe," from which he suffered a relapse. A slow fever set in, giving his relatives and friends much concern, but after a long vacation and a beneficial stay in the upper part of New York State, he returned recently very much improved in health and feeling quite like his former self.

PRESIDENT MORTON CONTRIBUTED A VERY EXTENSIVE ARTICLE, entitled "The Cosmogony of Genesis and its Reconcilers" to the April and July numbers of the *Bibliotheca Sacra*, published at Oberlin, Ohio. This contribution was prompted by an article which appeared in public print some time ago under the caption of "Religion and Science," and in which, among other statements, the following occurred. "They (many clear-minded Christian thinkers) believe that ultimately religion must fight science, and that therefore all attempts to temporize with it are not merely useless, but harmful." To this President Morton, in a letter accompanying his article to the editor of the *Bibliotheca Sacra* replied : "I desire to express most emphatically, both as a man of science and a professor of religion, my dissent from the views expressed and implied in the above quotation." President Morton's full reply has been reprinted in a very neat volume comprising sixty-five pages.

COMMODORE GEORGE WALLACE MELVILLE Engineer in Chief of the United States Navy, upon whom was recently conferred the degree of Doctor of Engineering by Stevens Institute of Technology, was the subject of an excellent biographical sketch which appeared in the April number of *Cassier's Magazine*.

MR. E. D. LEAVITT, upon whom the STEVENS INSTITUTE conferred the degree of Doctor of Engineering in 1884, will spend the summer in Europe, expecting to be absent about three months.

AT THE THIRTY-SIXTH MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS held at Hartford, Conn., May 25th to 28th, the following papers by Stevens graduates were presented :

GUS C. HENNING, '76 ; "A Pocket Recorder for Tests of Materials." This paper was reprinted in the *Engineering News*, June 3d.

PROF. W. S. ALDRICH, '84 ; "On Rating Electric Power Plants upon the Heat Unit Standard." It was largely abstracted in the *Engineering Record*, May 29th and reprinted in full in *Electricity*, June 2d.

PROF. D. S. JACOBUS, '84 ; "Influence of Moist Steam in the Economy of a Steam Turbine." It was reprinted in the June number of *Marine Engineering* and abstracted in the *Engineering Record*, May 29th, and also in the *Engineering News*, June 3d.

Another paper was presented by Professor Jacobus on "Measuring Pressures of 10,000 Pounds per Square Inch and Over." This appeared in the *Railroad Gazette*, May 28th, in the *Engineering News*, May 27th, and in *Iron Age*, June 3d.

PROFESSOR WOOD also presented a paper on "Adiabatics" which attracted much attention.

THE following Alumni registered their attendance at this meeting :

W. S. Aldrich, '84.
George M. Bond, '80.
B. B. Bristol, '93.
W. H. Bristol, '84.
C. T. Church, '95.
Hermann F. Cuntz, '93.
Geo. Dinkel, Jr., '88.
A. Faber Du Faur, '84.
E. H. Foster, '84.
H. L. Gantt, '84.
Gus. C. Henning, '76.
C. B. Hodges, '91.
David S. Jacobus, '84.
M. C. Jenkins, '87.
William Kent, '76.
F. V. Lawrence, '95.
J. W. Lieb, Jr., '80.
W. L. Lyall, '84.
Henry C. Meyer, Jr., '92.
G. M. Sinclair, '84.
H. W. Smith, '91.
Kenneth Torrance, '84.
A. J. Wood, '96.

PROFESSOR LEEDS, in a recent report to the Department of City Works of Brooklyn, showed that the trouble with the water supply of that city "was caused by the growth in the waters of the Ridgewood reservoir of the vegetable organism asterionella, often found in waters of good quality, and whose presence in drinking water, while making it unpalatable, does not directly affect its healthfulness or indicate the presence of serious contamination in the source of supply." PROF. LEEDS' solution of the difficulty is to cover the reservoirs, thus shutting off the light, which remedy has proved effectual in other places in stopping the growth of vegetable organisms.

AT THE ANNUAL CONVENTION of the American Water-Works Association held in Denver, Colo., June 8th, a paper from PROF. LEEDS on "The Causes of the Tastes and Odors Affecting the Brooklyn Water Supply in the Summer and Fall of 1896 and the Method of Prevention," was read.

Marine Engineering PUBLISHED MONTHLY BY THE "Marine Publishing Company" of New York, made its first appearance with the April number, which contained a very interesting article by our Trustee, COL. EDWIN A. STEVENS, on the subject, "The Origin and Development of the Ferry-boat." The "Educational Department" in the same number contained also an article by MR. HENRY L. EBSEN, Esq. Both of these articles were continued in the May number, in which appeared also a contribution on "The Analysis of Cylinder Deposits," by PROFESSOR STILLMAN. Mr. Ebsen's Educational Series are continued in the June and July numbers.

PROFESSOR JACOBUS delivered an interesting lecture before the Franklin Institute at Philadelphia, March [illegible]th, on "Artificial Light; Modern Methods compared; Electric-Incandescent, Welsbach, Acetylene." The lecture was introduced by numerous experiments showing that some colors were shown more perfectly under one light and some more perfectly under another. The Welsbach lamp failed in showing delicate shades of pink, and an experiment was made to show that it tended to give a yellow tinge to the complexion, whereas the acetylene light gave an effect much more lifelike than the Welsbach lamp. The relative rates of consumption of gas for a given candle power were discussed, together with the heat produced and the contamination of the atmosphere by the products of combustion. The Welsbach was shown to save [illegible] per cent. of the gas used by an ordinary flat flame burner for an equal amount of illumination. Acetylene gas was shown to be ten times as powerful an illuminant as ordinary water gas. It was shown that the ordinary flat-flame burner generates a total heat of 2[illegible] B. T. U. for a 16 candle-power-lamp per hour against [illegible] for the Welsbach, [illegible] for Acetylene and 25[illegible] for the Incandescent-Electric. The number of cubic feet of carbonic acid produced by a 16 candle power light per hour was shown to be, for the flat-flame burner, [illegible]; Welsbach, [illegible]; Acetylene, 0.[illegible]; Incandescent-Electric, 0.0. The safety of the various methods, together with the explosive properties of acetylene, was also discussed. The lecture has been widely copied by various scientific journals, among which are *Progressive Age*, May 1 and 15, *Electrical Engineer*, May 19 and 26, and the *Pharmaceutical Era*, June 17th.

THE EXERCISES CONSTITUTING THE WORK performed by the Senior Class during Supplementary Term have been increased this year by an Efficiency Test of Nash Gas Engine, the Determination of High Temperatures by the Uehling Pyrometer and the Determination of the Balance of Heat in a Boiler Test.

W. S. ALDRICH, '84, who is Professor of Mechanical Engineering in the West Virginia University, has accepted the position of Instructor during the Supplementary Term with a view to studying the methods employed by the Department of Experimental Mechanics and Shop Work in this part of the course. Mr. Jones, who is PROF. ALDRICH'S assistant at the above University is also taking the entire course as a student.

ONE HUNDRED AND FOURTEEN APPLICANTS presented themselves to take the June examinations for admission to the Institute. Of this number 92 came from the Stevens School. Seventy-one students took the examination with a view to entering the Institute next Fall; forty-three took only the preliminary subjects and expect to enter a year later.

THE INDICATOR REGRETS TO ANNOUNCE the sudden death of LESLIE J. ROBERTS of the Class of '98. He was one of the ill-fated party on the tally-ho coach which was struck and totally demolished by a train on the Long Island Railroad at the Merrick crossing, last Decoration Day. MR. ROBERTS was an ambitious young man and stood well in his class. His personality was quiet, progressive, amiable and always the one way. In his death the Institute loses an exemplary student and a prospective alumnus who gave abundant promise of being both a credit and an honor to his Alma Mater.

THE RECENT TWENTY-FIFTH ANNIVERSARY of the founding of the Stevens Institute of Technology was the means of bringing together a number of active and progressive mechanical and electrical engineers who are engaged in professional work, as educators in colleges and as editors of technical papers, and as consulting engineers, superintendents of motive power in railway work, manufacturers, draftsmen, etc.—Abstract from the *Electrical Engineer*, April 21, 1897.

THE *Link of '97* made its appearance on the 21st of May within three days of the time originally announced. The INDICATOR extends its hearty congratulations to the Board on the handsome book they have gotten out. The cover is of red buckram with a gold design stamped on the front and is one of the most striking features of the book. The frontispiece is an artistic engraving, in gold and colors and is a praiseworthy innovation. The artistic work is of a high order of excellence, there being an unusual number of half tones. The board is fortunate in having a number of friends of artistic ability, the cuts being one of the predominating features of the book. We notice the name of Mr. F. Louis Mora, Vice-President of the Society of American Artists, in the list of the *Link's* contributors. The literary matter is about the same as usual except in quantity, there being about fifty pages, almost all of which are contributed by the editors and the students. The editors composing the board are Warren H. Miller, *Theta Xi*, Editor-in-chief; Herbert R. Davis, Business Manager; G. R. Hemminger, *Delta Tau Delta*, Secretary; Fred A. Wells, *Beta Theta Pi*; E. H. Frank, *Chi Psi*, and R. C. Post, *Chi Phi*.

THE ENGINEER DIVISION of the Naval Reserve of New Jersey, Battalion of the East, was organized in March, 1896, when forty men were mustered in, about half of them being Stevens Institute men. Since then the division has grown to sixty men, the percentage of Stevens men being the same.

Last summer the Engineer Division, together with the Newark and Jersey City divisions, constituting the Battalion of the East, took a week's cruise through Long Island Sound, every one enjoying the event immensely. The cruise is an annual event, and is taken in the battalion's ship, U. S. S. *Portsmouth*, which, in the days of the old navy, was considered one of our finest and fastest vessels, and which is still perfectly sound and as seaworthy as ever. The cruise for this summer will commence July 24, and continue until August 7, being so arranged that the men can take either the first or second week, or both, to suit their own convenience. "The ship will proceed first to the eastern end of Long Island Sound, where it is expected that joint exercises will be held with the Naval Reserve forces of New York, Connecticut, and Rhode Island, and with such ships of the North Atlantic Squadron as may be detailed for that duty. From there the ship will sail for the Capes of the Delaware, returning up the New Jersey coast." The men are anticipating a fine time, knowing from the experience of last year that there will be plenty of fun, plenty of sleep, plenty to eat, and, incidentally, plenty of work, which, by the way, is very light for the Engineer Division.

Last winter the members of the division had the pleasure of attending a course of lectures delivered by Profs. Denton, Jacobus, and Geyer at the Institute.

All of the commissioned and most of the petty officers are Stevens students or graduates. At present the majority of the Stevens men in the division are from the class of Ninety-eight, each of the other classes, as well as Ninety-six, having several representatives. The division lacks about twenty men of being a full company, and there is no reason why these should not be Stevens men.

THE TAU BETA PI SOCIETY, held its regular initition of the second term, Tuesday, March 25. On that evening the men chosen from the list of those composing the highest eighth in standing of the members of the Junior Class were taken into the society. The initiates were F. Baker, H. R. Davis, A. C. Myers, and F. A. Welles. After the ceremonies were over a banquet was given in the Tau Beta Pi rooms.

At the beginning of the fall term, the Society will vote upon the names of those who at that time rank in the second eighth of the Class of '98 and also upon the name of the man of '99 in highest standing for the first two years of his course. The lists of men eligible to Tau Beta Pi are made up by the Faculty.

WE WERE PLEASED TO NOTICE a full announcement of the events of Commencement Week at Stevens in the *Railroad Gazette* of June 18th. The meeting of the Alumni Association was noticed particularly.

Messrs. Humphreys & Glasgow, formerly located at 66 Broadway, New York City, have removed to the New National Bank of Commerce Building, corner of Nassau and Cedar streets.

THE STEVENS SOCIAL SOCIETY gave one of its enjoyable dances on Tuesday, May 4th. The music for the occasion was by Giesmann and was of the usual excellent character. The large proportion of gentlemen present was very noticeable.

THE MUSICAL CLUBS. The officers elected by the several clubs for the following season are as follows:

Glee Club—President, A. F. Westervelt, '98. Vice-President, L. H. Johnson, '98. Leader to be elected in the fall. Sec. and Treas., A. MacDonald, '00.

Banjo Club—President, H. B. Upjohn, '99. Leader, F. Baker, '98, Sec. and Treas., P. C. Idell, '99.

Mandolin Club—President, R. S. Scott, Jr., '98. Leader, R. C. Post, '98. Sec. and Treas., H. R. Sanson, '99.

The Glee Club loses eight men, leaving one in each part.

On the Banjo Club, there will be left five men, but, as there is plenty of material in the Institute at present, there is no doubt about there being a good club next year. Mr. Baker has had a high standard raised for him by the retiring leader, Mr. R. L. Messimer, '97, but, with proper support, there is no doubt but what he has the ability to turn out a Banjo Club next season which shall do Stevens credit.

On the Mandolin Club, will be left one first and three second mandolins, two guitars and two violins. There are a number of men working for the club, however, and, under Mr. Post's efficient leadership, there is every reason to hope for a club next season which shall equal, at least, the very successful one of the past winter.

It is the intention of Leader Post to give out two or three pieces before the close of the year, so that the men may practise during the summer, and thus have a good start at the beginning of the regular club practice.

—*The Stevens Life.*

THE ENGINEERING SOCIETY held a business meeting on Monday, May 23. The main business of the meeting was the election of officers, which resulted in the following:

President, F. A. Welles; Vice-President, Fraley Baker; Secretary, M. P. Walker.

Executive Committee.—C. E. Grelle, Chairman; H. Brett; and E. B. Smith.

INSTITUTE PERSONALS.

'76.

GUS C. HENNING will attend the "Stockholm conference on Testing Material" to be held at Stockholm, Sweden, August 23-25. MR. HENNING goes as a delegate of the American Society of Mechanical Engineers. He expects to be gone about two months, leaving August 1st.

WILLIAM KENT'S article entitled "Efficiency of a Steam Boiler," originally read before the Franklin Institute of Philadelphia, has been reprinted in *The Safety Valve* and in *Ice and Refrigeration* for June.

'78.

"CONSTRUCTION AND MAINTENANCE of Railway Car Equipment" is the general heading for a series of articles written by Mr. OSCAR ANTZ and now current in the *American Engineer, Car Builder and Railroad Journal.* The scope of this subject may be appreciated by the following subdivisions of the title: Uniformity in Car Construction; Freight Car Construction in General; Capacity and Dimensions; Floor Frame; Body Bolsters; Draft Gears; Automatic Couplers; Freight Trucks; Truck Bolsters; Foundation Brakes; Brake Beams; Air Brake Apparatus; Flat or Platform Cars; Gondola Cars, Drop Doors; Box Cars, Roofs and Doors; Furniture Cars; Stock Cars; Tank Cars. The March number of the same paper contained also an article on "A Snow Flange Operated by Air," which was designed and constructed under the supervision of Mr. Antz.

IN AN ARTICLE ENTITLED "Profitable Day Load in Alternate Current Systems" in the *Electrical World*, the following appears: "Through the ingenuity of MR. JOHN F. KELLY, M. E., an alternating current booster has been devised which has neither commutator nor brushes, and is in every way simpler than the direct current booster, which comprises two machines and two commutators. With the alternating booster any feeder may be combined in precisely the same way as in direct current stations."

EDWARD P. THOMPSON, in connection with Mr. W. A. Anthony, is the author of a new book entitled "Roentgen Rays." It is bound in cloth and contains 190 pages. *Ice and Refrigeration* says "it not only treats of the Roentgen rays, and their use for obtaining shadow photographs, but it covers the whole field of radiant energy, the relations between magnetism, electricity, light, heat, etc., and gives in detail the most recent researches and experiments which indirectly or directly bear upon this interesting subject."

'80.

AT THE FIFTH ANNUAL DINNER of the New York Electrical Contractors' Association, held in New York City, April 21, MR. J. W. LIEB, JR., responded to the toast, "The Illuminating Companies," and described vividly the crude conditions of early supply of current from central stations,

the first Edison plant in New York having neither voltmeter nor ammeter. With the advance in central station work, had gone a higher standard of wiring construction with great advantage all around. MR. LIEB also attended the annual meeting of the Institute of Electrical Engineers held in New York City, May 18th, and responded to the toast, "The Art of Shutting Down Central Stations."

'82.

GEORGE GIBBS, who is mechanical engineer for the Chicago, Milwaukee and St. Paul Railroad, received partial acknowledgment from the June *American Engineer, Car Builder and Railroad Journal* for photographs and information made use of in the description of a "Locomotive Turntable Operated by an Electric Motor." MR. GIBBS was present at the meeting of the Western Railway Club held at the Auditorium Hotel, Chicago, and took a prominent part in the Discussion on "Locomotive and Car Lubrication."

THE *Electrical Engineer* of April 7th, contains a twelve page article including a large number of illustrations, entitled "The Narragansett Electric Lighting Co.: The Evolution of a Typical Composité Station," from the pen of MR. JOSEPH WETZLER.

'84.

THE FOLLOWING IS TAKEN FROM THE *Engineering News* of June 3:

A greater variation in locomotive fuel consumption of an engine results from a variation in the number of cars per train than from a variation in the weight of the train, the number of cars being constant, according to experiments conducted by MR. S. P. BUSH, Superintendent of Motor Power, Pennsylvania Lines West of Pittsburg. The experiments noted consisted in taking a large number of observations on trains running between Chicago, Ill., and Logansport, Ind., 115 miles, (1) on trains of equal weight but a varying number of cars, (2) on trains of an equal number of cars, but varying weight. In the first case, that is, with a constant weight and a variable number of cars, the records show that the fuel consumption increases very uniformly as the number of cars in the train increased. In the second case, the records give rather irregular results in individual cases, but show quite clearly that with a given number of cars in the train very little variation in fuel consumption results, whether these cars be lightly or heavily loaded. For example, in one train of 32 cars the increase in fuel consumption was only about 400 lbs. between a weight of 750 tons and a weight of 1050 tons. Mr. Bush concludes: As a result of the above information it can easily be seen that under the conditions existing on this particular division a flat car-mile basis—that is, calling a car a car, whether loaded or empty, and making the necessary adjustment for the weight—would be the most accurate basis for measuring the work performed by engines and train crews, and for all practical purposes the adjustment on account of weight could be omitted entirely.

A full account of the above subject, together with plotted diagrams, appeared in the June number of the *Railway Master Mechanic.*

DABNEY H. MAURY, Superintendent of the Peoria, Ill., Water Works, presented a paper on "Special Contracts in Water-Works Business" at the annual convention of the American Water-Works Association, held in Denver, Colo., June 8th.

HARRY DEB. PARSONS' lecture before the Senior Class of the STEVENS INSTITUTE on "Business Methods for Engineers" appeared in the *Engineering Record* of May 22d and in *The Engineer* under date of May 8th. Under the caption, "Mechanical Fallacies," the latter journal, of June 5th, contained an extract from one of MR. PARSONS' lectures on "The Law of the Conservation of Energy, as Related to Perpetual Motion and Similar Fallacies," delivered before the students of Rensselaer Polytechnic Institute at Troy, N. Y.

MR. PARSONS was recently appointed by Governor Black to be one of three commissioners to examine voting machines, in accordance with chapter 450, Laws of the State of New York, 1897. The other members of the commission are Philip T. Dodge, patent lawyer, and Professor Robert H. Thurston, of Cornell University. The term of office is five years.

'85.

ARTHUR G. GLASGOW arrived from England on the steamship *St. Paul*, May 1st, for a short visit, returning June 5th.

Progressive Age, under date of June 1st, contains the following:

The importance of periodical tests of main pipe is recognized by every gas manager, but its most satisfactory accomplishment by isolating blocks or streets with a valve system is possible to very few. Mr. J. M. Rusby, of Jersey City, informs us of his use of bags in lieu of valves, and success with this convenient substitute should result most advantageously. A description follows.

'86.

FRED N. MORTON has been appointed Superintendent of the Hudson County Gas Light Co. at Hoboken, N. J.

'87.

JULIUS CALISCH, who is in the Railway Department of the Pennsylvania General Electric Company at Pittsburg, was in attendance at the twentieth convention of the National Electric Light Association, held at Niagara Falls, N. Y., June 8, 9 and 10.

JOHANNES H. CUNTZ translated and condensed for the June number of *Cassier's Magazine* an article on the "Electric Power at Rheinfelden, Germany," which was presented, originally, by Dr. Rathenau at the Berlin meeting of the Verband Deutscher Elektrotechniker.

J. DAY FLACK has been appointed Superintendent of the Home Ice Machine Company of Baltimore, Md. He is at present reconstructing the plant, which is located at 713 Swan Street, in the above city.

CHARLES ANDREWS HALL and Miss Hattie Ross Triplett were married June the first at the Christ church, Mobile, Alabama. Mr. Hall is General Manager of the Mobile Phosphate and Chemical Manufacturing Company.

'87.

WILLIAM E. QUIMBY, who recently obtained patents on the "Quimby screw pump," is now engaged in the manufacture of the same, with office at 122 Liberty Street, New York City.

HERBERT A. WAGNER delivered an address at the four hundred and fifty-fifth meeting of the Engineers' Club of St. Louis, held May 19th, on the subject, "The Electric Lighting System of the City of St. Louis." The address was largely discussed by the engineers present. MR. WAGNER also attended the twentieth convention of the National Electric Light Association, held at Niagara Falls, N. Y., June 8, 9, and 10, where he exhibited a self-starting, single-phase, alternating current motor, alternating switchboard instruments, ceiling fans and a multipolar direct-current motor.

'88.

ALTEN S. MILLER was present at the twentieth annual convention of the Western Gas Association, held in Cincinnati, May 19, 20 and 21, and participated in several of the discussions. MR. MILLER has been specified by the Council of American Gas Light Association to serve on the standing committee of arrangements.

'90.

HENRY TORRANCE, JR., is Manager of the New York office of the Hendrick Manufacturing Company, Ltd., of Carbondale, Pa. His office is in the Havemeyer Building, 26 Cortlandt Street, New York City.

'91.

MR. W. S. ACKERMAN, Consulting Engineer for the past three years for the National Lead Company, and Mr. Albert Randolph Ross, formerly with Messrs. McKim, Mead & White, have formed the partnership of Ackerman & Ross, architects, with offices at No. 156 Fifth Avenue, New York City.—*Engineering Record*, June 5th.

JESSE A. DAVIS has accepted a position in the office of the Naval Inspector of Steel at the Midvale Steel Co., Philadelphia, Pa.

J. A. DIXON, who is an active member of the Western Gas Association, attended their twentieth annual meeting, which was held in Cincinnati, May 19, 20 and 21.

JULIAN C. SMITH has formed a partnership with D. G. Morton under the firm name of Morton & Smith, engineers and contractors, with an office in the Law Building, Baltimore, Md. This firm has secured a number of contracts and has been kept very busy.

MR. SMITH and Miss Elizabeth Clarke, daughter of Dr. Powhatan Clarke of Baltimore, were married at the home of the bride, June the second.

'92.

FRED. W. COHEN, who is Assistant Engineer for "The Bridge and Construction Department of the Pennsylvania Steel Company," is now located temporarily at Suspension Bridge, N. Y., in the capacity of Resident En-

gineer for the above company in the construction of the new steel arch bridge which is to replace the old suspension bridge which was the first structure ever thrown across the Niagara Gorge. The new bridge is double-tracked and is designed to accommodate the immense traffic between the West and the East. *The Illustrated Buffalo Express* of Sunday, April 26th, contained an extensive article descriptive of the construction and progress of the bridge and, among other illustrations of those prominent in this work was that of MR. COHEN.

HOWARD [illegible] GURNEY has resigned his position with the Sprague Electric Elevator Co., and is now with Chas. [illegible] Parker & Co., engineers, of [illegible] William Street, New York City. The latter firm have a contract with the State of New York to deepen a six-mile section of the Erie Canal west of Lockport. Mr. Gurney was given charge of this contract and he is now temporarily located at Lockport, N. Y.

THOMAS [illegible] JENKINS, formerly of the Class of [illegible], has been appointed superintendent of the "City and Suburban Railroad" of Baltimore, Md.

NICHOLAS S. HILL, JR., is chief engineer of the Baltimore City Water Department, Baltimore, Md.

[illegible] LITCHFIELD has removed from Philadelphia, and is now in the employ of [illegible] & [illegible], engineers, Twenty-second Street and Fourth Avenue, New York City.

HERBERT [illegible] MERRILL is chief draughtsman in the construction department of the Sprague Electric Elevator Company, [illegible]25 Broadway, New York City.

[illegible] for several years in [illegible] of the [illegible] Sprague [illegible] manufacturing department [illegible]. The engagement of Mr. [illegible] and Miss [illegible] is announced.

[illegible]

[illegible] has received the degree of [illegible] and has [illegible] Nassau Street, New York City. His [illegible]. Mr. [illegible] still remains [illegible] with the *American [illegible]* as Assistant Editor.

[illegible] Electric [illegible] Company [illegible].

[illegible] is now with the Maccallum [illegible] Co., [illegible] Street, [illegible], Mass.

[illegible] is general manager of the Bullock Electric [illegible] Building, New York City. The following paragraph is taken from the [illegible] of May [illegible].

Mr. [illegible], of the Bullock Electric Manufacturing Com-

pany says in the *American Machinist*: "When electrical transmission stepped to the fore, even the best equipped factories presented a most inconsistent appearance. Their condition might be compared to two strong iron links of a chain held together by a piece of string, for on the one hand their boilers and engines were of the best and most economical types, and on the other hand their tools or printing presses were compact, automatic and highly efficient. But the connecting link, the means of transmitting the power from the engine to the tool, was a weak one, a great source of waste in power and a relic of conservatism. It is astounding that for years, thousands (indeed, one may say millions) of horse-power hours have been wasted in the mere friction load of shafting and belting, without any serious consideration of the matter by mill owners and printers. Records of tests made in over two hundred representative factories and printing establishments of this country alone show, as an average, that about 50 per cent. of all the power generated by the engines has been wasted in belt or rope transmission of power."

CHARLES W. MACCORD, JR., has severed his connection with *Power*, and has accepted a position with McIntosh, Seymour & Company of Auburn, N. Y., as specification writer. MR. MACCORD has written a treatise on Valve Gears in which many of the problems are solved in a new or an original manner, with a view to presenting the subject to those who have not had the benefit of a technical education, in a way that will be easily understood. The book will be published shortly by John Wiley & Sons of New York City.

THE announcement for 1897–98 of the University of Minnesota contains the name of G. ROSENBUSCH, M. E., as special lecturer in "The College of Engineering and the Mechanic Arts."

'95.

F. N. MACVEETY is Chief Engineer for Pierce & Miller, General Contractors and Consulting Engineers with offices in the Havemeyer Building, New York City. He is at present engaged in the construction of the new trolley line between Rutherford and Paterson.

GEORGE S. MONTGOMERY, formerly of the class of '95, is Engineer for the Laclede Power Co., contracting Electrical Engineers, at St. Louis, Mo.

CHARLES P. PAULDING contributed a three page article with four good sized illustrations, entitled "Machinery of the Copper Mines of Michigan," to the *American Machinist* under date of April 8, 1897. Mr. Paulding is now in the employ of the American Impulse Wheel Company, 120 122 Liberty Street, New York City.

'96.

W. J. A. BOUCHER is employed as draughtsman by the American Motor Co., 1304 Hudson Street, Hoboken.

S. F. BUTTERWORTH returned from a trip to Europe, May 17th. While abroad he visited Italy, France, Holland and England.

WALTER H. DICKERSON is associated with Mr. Charles H. Tripler who

is making investigations of air under high pressures and of the liquefaction of air.

JOHN P. KENNEDY is in the employ of Humphreys & Glasgow at their London office.

R. T. KINGSFORD is with the newly organized American Impulse Wheel Company of 120–122 Liberty Street, N. Y. City, as assistant to their Consulting Engineer.

W. H. MACGREGOR is located corner 7th and Clinton Streets, Hoboken, with the Ward Leonard Co., who were totally burned out in May last.

LEONARD SEELIGSBERG is agent for W. C. Baker, dealer in Boilers and Heating Apparatus, at 43 Liberty Street, New York City.

'97.

ALBERT BEUTLER, JR., is with the American Motor Company, 1304 Hudson Street, Hoboken, N. J.

ROGER CHEW is inspector for the New York Telephone Company, 18 Cortlandt Street, New York City.

WARREN DAVEY is temporarily engaged at Colgate's Soap Factory in Jersey City in determining the distribution of steam in the works, where forty pumps and 5 engines are in operation.

WILLIAM F. DOUGHTY is employed by the New York Sugar Refining Company at Long Island City, N. Y., as draughtsman.

WILLIAM D. ENNIS is with the Consolidated Gas Company of New Jersey, 168 Broadway, Long Branch, N. J.

JAMES F. HUNTER is in the employ of the Pennsylvania Steel Company at Sparrows Point, Md.

ALEXANDER B. MACBETH is with the B. F. Sturtevant Company at 131 Liberty Street, New York City.

ROBERT L. MESSIMER is Assistant Superintendent of Motive Power at the Calumet and Hecla Mines, Calumet, Michigan.

ARTHUR B. MILLER is special instructor of Manual Work and Mechanical Drawing in the Ethical Culture Schools, New York City. Mr. Miller held this position for several months before graduation.

FREDERICK OPHÜLS has accepted a position with the De La Vergne Refrigerating Machine Company, 138th Street and East River, New York City. MR. OPHÜLS will spend two months in the draughting rooms, after which he will enter the shops.

PAUL S. WHITMAN is draughtsman at the Carnegie Steel Works, Pittsburg, Pa.

ATHLETICS.

Lacrosse.—Although an unsuccessful attempt was made this year to win championship honors in the Intercollegiate League, there is every reason to believe that, with almost the same team, efficient coaching, and the help of the practice games with Crescent, Captain Scott will land the championship next year.

Crescent's English trip operated most disastrously for Stevens, as the experience gained by these practice games in former years has been very valuable, and has been the means of giving Stevens more confidence in the league games.

The introduction of a training table would infuse new life into athletics, and would be a great benefit, especially to the Lacrosse team ; for if there is a game which demands perfect physical condition for its success, it is Lacrosse.

The following games were played :

April 24,	at Bay Ridge	Stevens	3	2d Crescent A. C.	0
" 27,	" Montclair	"	8	Montclair A. C.	0
May 1,	" Hoboken	"	10	2d Crescent A. C.	0
" 8,	" Baltimore	"	2	Johns Hopkins	6
" 14,	" Hoboken	"	10	Harvard	4
" 22,	" Hoboken	"	4	Lehigh	9

Stevens vs. 2d Crescents.—These two games, and also the one with Montclair, were the means of affording practice to the attack of Stevens, but the defense had practically nothing to do. The teams were very unevenly matched, and as a consequence, the games were uninteresting.

Stevens vs. Johns Hopkins.—In marked contrast to the clean, pretty game of last, was the rough game of this year. Hopkins undoubtedly played a strong game, with good team work in the attack, and the almost phenomenal catching of Maddren in the defense ; but there was no excuse for their apparently intentional slashing of the Stevens attack men.

During the first ten minutes play, the ball was shot by our attack almost constantly, their uncovering and passing being all that could be desired : but inaccurate shooting, combined with good stops by Hopkins' defense prevented their scoring. The first half closed with the score : Hopkins 4, Stevens 1. In this half two of our shots hit a post, one goal was claimed, and another protested by Stevens, neither of which was allowed.

In the second half, our defense men were very much in evidence, and Hopkins' attack found it a very difficult matter to get the ball by them. Indeed, had it not been for the rough, unkept grounds on which the game was played, there might have been a very different story to tell.

The teams lined up as follows :

Stevens.	Positions.	J. H. U.
Sofio	Goal	Guggenheimer
Buckley	Point	Maddren (Capt.)
Grelle	Cover Point	Luxton
Brune	1st Defense	Kennard
Kidde	2d "	Hodges
MacDonald	3d "	Smith
Christy	Centre	Wilson
Weichert	3d Attack	Fitzgerald
Lent	2d "	Robinson
Scott (Capt.)	1st "	Strauss
Kennedy	Outside Home	Clunett
H. Sanson	Inside Home	Naylor

Referee, Mr. S. J. Poe. Umpires, Messrs. Pennington and Hopkins, of the Druids, of Baltimore.

Time, two thirty-five minute halves. Goals—Christy 2, Naylor 3, Fitzgerald 2, Strauss 1.

Stevens vs. Harvard—Harvard presented a team in perfect physical condition, but a team whose method of play could be greatly improved upon. Harvard was weak, but she managed to push four goals through the posts for all that.

The teams lined up as follows:

Stevens.	Positions.	Harvard.
Sofio	Goal	Land
Wachter	Point	Wilder
Grelle	Cover Point	Woods
Brune	1st Defense	Cooley
Kidde	2d "	G. Breed
MacDonald	3d "	N. Breed
Christy	Centre	Ladd
Weichert	3d Attack	Beecher
Lent	2d "	Brookings
Scott (Capt.)	1st "	Taylor
Kennedy	Outside Home	Burley (Capt.)
H. Sanson	Inside Home	Ring

Referee, Mr. McConaghty, Crescent A. C.

Umpires, Mr. Brown, Harvard; Mr. Church, Stevens.

Time, two thirty-five minute halves.

Goals, Scott 5, Weichert 3, Kennedy 1, Christy 1, Beecher 2, Taylor 2.

Stevens vs. Lehigh.—If ever lack of condition asserted itself, it certainly did on this occasion. At the end of forty minutes play, the score stood 3—3. Stevens, however, could not stand the pace, and six goals in twenty minutes resulted.

Lehigh's team work, especially in the attack, was certainly pretty; and their stick handling was above criticism.

When the ball was in Stevens attack, the centre men helped matters along there also, which was all very good; but when the attack lost the ball and it went sailing down to Lehigh's attack, our centre men seemed totally unable to get back to their positions; the result of which was that Lehigh always had one or two men in their attack more than in Stevens defense. It was then a very easy matter for her attack to uncover, and waiting to be checked, to pass the ball to the man left uncovered by the checking man. This method of play was what enabled Lehigh to win out the game. It amounted simply to clear head work, and their beautiful stick handling.

The teams lined up as follows:

Stevens.	Positions.	Lehigh.
Sofio	Goal	Pennington
Buckley	Point	Good
Wachter	Cover Point	Miller
Grelle	1st Defense	Boyt
Kidde	2d "	Gomery
MacDonald	3d "	Paddock
Christy	Centre	Edgar
Weichert	3d Attack	Merriman (Capt.)
Brune	2d "	Roundy
Scott (Capt.)	1st "	Lee
Kennedy	Outside Home	Symmington
H. Sanson	Inside Home	Thurston

Referee, Mr. Willett; Stevens, '96.
Umpires, Messrs. Iles and Massey, Lehigh.
Time, two thirty-five minute halves.
Goals, for Stevens, Sanson 2, Kennedy 2.

The Annual Sophomore-Freshman Lacrosse game was played May 24, and resulted in a win for '99 by a score of 3—2. The game was an interesting one, as it gave an opportunity to watch the work of some of the new men.

The goals were scored by Luqueer (2) and H. Sanson for '99 and by Brooks and Stanford for 1900.

THE ANNUAL FIELD GAMES were held at the Cricket Grounds, Wednesday, June 2. The entry-list was smaller than usual and those who took part in the track events were handicapped by a poor course. Two Institute records were broken—one by C. R. Tock, '98, who threw the hammer 85 feet; the other by E. Davis, Special, who put the shot 34 feet, 4 inches. Ninety-eight won the class championship with 31 points; '99 secured 27½ points, '97, 10 and '00, 8½.

THE SOPHOMORE-FRESHMAN BASEBALL GAME was played on the afternoon of May 14 and resulted in a victory for the class of '99, the score being 11 to 4. The feature of the game was the pitching of H. Sanson, Captain of the Sophomore team, who struck out 17 men.

PROFESSIONAL.

Alfred M. Mayer

THE STEVENS INDICATOR.

VOL. XIV. OCTOBER, 1897. No. 4.

OBITUARY.

ALFRED MARSHALL MAYER.

Professor Alfred M. Mayer died July 13th at his country residence in Maplewood, N. J. He was in the sixty-first year of his age.

For nearly a year he had been in failing health, due to the results of zeal and overwork in conducting his original private researches. He continued to perform his duties at the Institute until the latter part of February, when during the Twenty-fifth Anniversary celebration he personally exhibited a number of original working models illustrating several scientific phenomena. On account of continued and increasing weakness and exhaustion this was his last work at the Institute. A few weeks later a trip through Southern Europe was intercepted by an attack of an apoplectic nature as he was about to sail. Shortly after this he retired to the quiet of his country home where he lingered for several months and finally died of meningitis.

The funeral services were held in the Church of the Holy Communion at South Orange, N. J., on July 15th. A large representation from the faculty were present and acted as honorary pall-bearers. Professor Mayer's nephew, the Rev. Henry Mayer, of Philadelphia, and the Rev. Dr. George C. Houghton, of Hobo-

ken, performed the last sad rites. The interment took place in the Rosedale cemetery at Orange, N. J. Professor Mayer leaves a widow and one son who was graduated from Stevens Institute in 1890.

Professor Alfred M. Mayer was a son of Charles F. Mayer, a distinguished jurist of the Baltimore bar and a nephew of Col. Brantz Mayer, U. S. A., the historian and founder of the Maryland Historical Society. He was born in Baltimore, Md., Nobember 13th, 1836.

He was educated at St. Mary's College, Baltimore, which institution he left in 1852 to enter the workshop and draughting room of a mechanical engineer where he acquired a knowledge of mechanical processes and the use of tools for which he had a natural aptitude. He remained in this place for two years and then followed with a course of laboratory practice in physics and chemistry for two years more, during which period his first contribution to science, entitled "A New Apparatus for the Determination of Carbonic Acid" was published both in this country and in Europe. It was at this time that he attracted the attention of Joseph Henry who was then Secretary of the Smithsonian Institution, and who had been for thirty years identified with the advancement of pure science. The encouragement which young Alfred Mayer received from this distinguished scientist did much to influence him to a life devoted to scientific research and the many students who have passed under Professor Mayer will remember his grateful tributes and frequent allusions to the work of Joseph Henry.

At the remarkably early age of twenty years he was made Professor of Physics and Chemistry in the University of Maryland and three years later, accepted a similar position in the Westminster College, Missouri. He went abroad in 1863 and entered the University of Paris, where he pursued his studies in physics, mathematics and physiology. While in Paris he was a pupil of the distinguished physicist, Regnault. On his return to this country in 1865, he became Professor of Physics in Penn-

sylvania College, Gettysburg, where he remained until 1867 when he was called to the chair of Physics and Astronomy in Lehigh University where he designed and equipped an astronomical observatory, erected the delicate instruments and finished the tedious work of adjusting them, without assistance. A series of systematic observations on Jupiter were made, the results of which were published on two continents.

During the summer of 1869 the U. S. Almanac Office selected Professor Mayer to take charge of a party of astronomers at Burlington, Iowa, where observations of the total solar eclipse of August 7th were made. Forty-two perfect photographs were taken with exposures of 0.002 seconds each. This was in the early days of photography and was accounted an unusual feat; five of these photographs were taken during the eighty-three seconds of totality. The results of this work were published in an elaborate paper in the Journal of the Franklin Institute and in the publication of the U. S. Almanac Office. While at Lehigh University he published, also, a number of articles on physical and astrophysical subjects and in 1869 read a paper at the Salem meeting of the Scientific Association on "The Thermodynamics of Waterfalls" based on observations made at Trenton Falls and at Niagara Falls.

In 1871 Professor Mayer was called to Stevens Institute of Technology to organize and take charge of the department of physics. Of his connection with Stevens, *Science* of Aug. 20th says: "it is with this institution, therefore, that his name will be chiefly identified, though his researches were for the most part in channels somewhat removed from those that are usually characteristic of an engineeering school. Its instrumental equipment was unusually good, and proximity to a great metropolis afforded the intellectual stimulus and the prompt recognition of merit which are wanting in isolated institutions of learning." The same journal also says that "soon after entering upon his duties at Hoboken, Professor Mayer began the series of investigations in acoustics for which he is perhaps best known, and which made him decidedly the leading authority on this subject in America."

One of the strong points of Dr. Mayer's character was his

great industry in his profession and he has been alluded to as the "prince of experimenters." His labors since 1855 have resulted in about one hundred publications of which six are standard books. All of his writings are characterized by a clear and graceful style, and embody that personal charm of originality which he alone possessed. Acousties was his favorite field of research, although electricity, electro-magnetic phenomena and optics, especially photometry and color-contrasts received much of his attention. His researches were given to the world through the media of various publications, but principally in the *American Journal of Science.* The following list of titles will give some notion of his wonderful and numerous achievements:

*The translation of a vibrating body causes it to give a wave-length differing from that produced by the same vibrating body when stationary (1872): a method of detecting the phases of vibration in the air surrounding a sounding body; and thereby measuring directly in the vibrating air the length of its waves and exploring the form of its wave-surface, resulting in the invention of the topophone (1872) of which it is said "the difficulties attendant upon such an experiment are very great and no one but an experimentalist of exceptional skill and patience would be apt to undertake it": a simple and precise method of measuring the wave-lengths and velocities of sound in gases; and on an application of the method in the invention of an acoustical pyrometer (1872): the experimental determination of the relative intensities of sounds; the measurement of the powers of various substances to reflect and to transmit sonorous vibrations and the invention of an instrument with which a sound at sea, such as that of a fog horn, could be heard with a close approximation to accuracy (1873): experimental confirmation of Fourier's theorem; experimental illustration of Helmholtz's theory of audition; experiments on the supposed auditory apparatus of the mosquito, in which it is shown that the fibrils of the antennæ of the male mosquito vibrate sympathetically to sounds having

*For the list of titles here presented due credit is given to the *American Journal of Science*, which has collected them from all sources in a very thorough manner. To this list, however, has been added a number of interesting notes from a very extensive and excellent obituary in *Science*, written by Prof. W. Le Conte Stevens of Troy, who was a very close friend of Dr. Mayer.—EDITOR.

the range of pitch of sounds emitted by the female mosquito; suggestions as to the function of the spiral scale of the Cochlea; six experimental methods of sonorous analysis; curve of musical note formed from six sinusoids of the first six harmonics; curves for various consonant intervals; experiments in which motions of a molecule of air are derived from these for six elementary vibrations of a musical note (1874): determination of the law connecting pitch of sound with the duration of residual sensation, which is regarded as his greatest work. The *Musical Courier* states that "it is the most important as it lies at the very foundation of the physics of music." The law established as a result of this investigation has come to be known as "Mayer's Law" and gives according to *Science* "a quantitative character to results which Helmholtz had attained qualitatively. It is of fundamental importance in its application to musical harmony and explains why certain combinations of tones, which are harmonious on the upper portions of the musical scale, become rough and discordant in the lower portions. This fact had long been known and recognized to musical composers but had been inexplicable. As a result of the labor involved in this investigation the power of audition in one ear was permanently impaired"; determination of the number of beats throughout the musical scale which produce the greatest dissonances; application of these laws by means of rotating perforated disks, and quantitative application of them to musical harmony (1874): experiments on the reflection of sound from heated flames and heated gases (1874): obliteration of one sound by simultaneous action of a more intense and lower sound; discovery that a sound even intense cannot obliterate sensation of a sound of lower pitch (1876): acoustic repulsion (1878). This investigation led to the construction of the "sound mill," which is composed of a pair of resonators so balanced and pivoted on their supports as to be set in rotation by reaction, on sounding near them a tuning fork to which they are adapted. This phenomenon was shortly afterward discovered independently by Dvorâk in Austria: determination of the smallest consonant intervals among simple tones, and application to deduce the duration of residual sonorous sensations (1894): variation in the modulus of elasticity with change of temperature determined by

transverse vibrations of bars at various temperatures. In connection with this investigation it was necessary for Professor Mayer to visit Paris where access was had to Dr. Koenig's grand tonometer and where this famous acoustician freely gave his time and skill in furtherance of the work ; the acoustical properties of aluminum, showing that the metal is unsuited for musical instruments on account of the rapid and large changes in its elasticity by change of temperature (1896). In an elaborate paper published in the third volume of the Memoirs of the National Academy of Sciences, 1884, he gave a method of precisely measuring the vibratory periods of tuning-forks and was the first to give accurately the correction to be applied in all such determinations on account of variation of temperature of the fork. He also devised methods for determining the laws of the vibration of tuning-forks, together with their applications in chronoscopes, for measuring the velocity of projectiles.

Among other papers published by Professor Mayer in the *American Journal of Science* may be mentioned : Researches in electro-magnetism, showing the changes in dimensions of iron and steel bars by magnetization ; method of measuring electrical conductivity by means of two equal and opposed electrical currents (1870, 1873) : on the electro-tonic state ; on a method of fixing magnetic spectra (1871) : new form of lantern galvanometer ; mode of tracing the boundary of a wave of conducted heat (1872): on the composite nature of the electric discharge (1874): method of delineating the isothermal lines of the solar disk (1875) : experiments with floating magnets (1878): the well-spherometer (1886): the pendulum electrometer ; electric potential as measured by work ; the spring balance electrometer ; experimental proof of Ohm's law ; cubical expansion of solids, by vessels or hydrometers made of the material of these solids (1890): illuminating power of flat petroleum flames ; physical properties of hard rubber showing that it has a remarkably large coefficient of expansion, exceeding that of mercury (1891): simultaneous contrast-color ; photometer for lights of different color which gives a degree of accuracy in excess of that usually obtained by the Bunsen photometer (1893) : researches on the Röntgen rays, showing by formulæ the transmissive powers of several substances

for these rays (1896); equilibrium of forces acting in the flotation of disks and rings of metal, with determinations of surface tension (1897). This, his last research, is characterized by *Science* as "fully, if not superior, to the best hitherto accomplished by Plateau and Quincke. It was done during the intervals between periods of acute physicial suffering and its appearance in the *American Journal of Science* for April of the present year preceded by only a few days, the paralytic stroke which demonstrated that the investigator's life work was already ended."

Professor Mayer also published "Lecture Notes on Physics" in a series of articles in the *Journal of the Franklin Institute* and subsequently in book form (Philadelphia, 1868); "The Earth a Great Magnet," which was one of a series of public lectures and was delivered by invitation before the Yale Scientific Club (New Haven, 1872); "Light" together with "Sound" comprise two small volumes which contain the results of a large number of experiments and demonstrations which have been largely copied into the elementary text-books of to-day (New York, 1877); "Sound" (New York, 1878); "Sport with Gun and Rod in American Woods and Waters" (1883).

In addition to this experimental and literary work, Professor Mayer wrote many of the articles on physics in Appleton's and Johnson's cyclopædias. He also contributed a large number of popular science articles to the *Scientific American*, the most important of which, was a long series on the "Minute Measurements of Modern Science." This was also published in the *Scientific American Supplement*.

In 1873 he became one of the associate editors of the *American Journal of Science* and contributed five articles to its columns during the first eight months of that year. Partial failure of his eyesight then necessitated cessation from all work and the greater part of the next scholastic year was spent in Europe where hospitable entertainment was accorded him by the most prominent representatives of science.

The degree of Ph. D. was conferred upon Professor Mayer in 1864 by the Pennsylvania College. In 1872 he was elected a member of the National Academy of Sciences and was connected with many other scientific societies, among which may be men-

tioned The American Philosophical Society, The American Academy of Arts and Sciences, The New York Academy of Sciences and the American Meteorological Society. He was a corresponding member of the British Association for the Advancement of Science, and a Fellow of the American Association of the same name ; he was also a member of the Century Club.

With all the scientific work which Professor Mayer accomplished in his three-score years, he found much time to devote to out-door recreation. While in youth he became an accomplished marksman and during his entire life was an exceptionally successful sportsman. In 1884 he won the national championship in minnow-casting with a rod of his own invention. The columns of the *Century Magazine* have frequently received articles from him on sporting subjects and in 1883 he edited and was author of a number of chapters of a superbly illustrated book entitled "Sport with Gun and Rod in American Woods and Waters." This book is spoken of by the *Scientific American* as "one of the finest books on sports that has ever been produced."

Professor Mayer also took particular pleasure in the study of Archæology in which subject he showed an unusual acumen. While in France some years ago he secured some remarkable finds of prehistoric handiwork, almost in the identical places where Boucher de Perthes carried on his earliest researches more than sixty years ago.

We now turn, from the remarkable record of achievement of a well-rounded life, to the personality of our subject and to the expressions of admiration and love which have appeared in public print and which now arise within us. The *American Journal of Science* closes his obituary with the following tribute: "Professor Mayer's scientific work was marked by strongly characteristic traits. He possessed a remarkable degree of delicacy and precision as an experimenter, which enabled him to obtain results that will have a high and permanent value in science. Beyond his scientific accomplishments, he was a man of high and refined culture, with a genial presence and social qualities which made him a delightful companion and endeared him to his friends."

This very brief allusion is but one of the many that have appeared in the scientific periodicals of two continents, and all

go to show in what very high esteem he was held both as a scientist and as a man. As a teacher we knew him best, and it is safe to state that there is not one, who has ever been so fortunate as to come under his instruction, but that will say it was always a pleasure to meet Professor Mayer in the class-room or in the laboratory. His instruction was not confined to the stereotyped phrases of the text-book, nor was it limited in scope to the matter between the covers. His knowledge seemed inexhaustible and he would lecture, impromptu, with fluency on any subject which the student might raise; and with it all there was not one particle of vanity in his nature. He taught the student to realize how much there was to know in this world by frequently emphasizing how little he knew himself, and if there was any conceit lurking in the student's nature it was bound to suffer by irresistible comparison. He had an interesting way of presenting a new subject that made it seem so simple, so entertaining and so practical that the student's attention was firmly held, and it is safe to say that many forms of apparatus have been constructed to exemplify the various laws of physics as he has demonstrated them, as a result of the inspiration received in his class room. In the laboratory his great *delicacy* and *precision* have taught invaluable lessons, not only in the use of instruments and the determination of data by means of the same, but in grounding these inestimable qualities, which are of great advantage in a world which is rapidly becoming more exacting in all its processes and in its demands upon the leaders of thought. His ideal personality, embracing as it did knowledge, ability and courtesy, has won the love and esteem of those who now comprise the Alumni of the Stevens Institute of Technology and of the undergraduates who have been fortunate enough to meet him.

Taken altogether, one is impressed with the thought that Professor Mayer, by indefatigable devotion to science, has won for himself a niche in the temple of fame and that his contemporaries have accorded him a place among the greatest men of his age.

VELOCITY DIAGRAMS AND THEIR CONSTRUCTION.

BY PROF. C. W. MAC CORD. SC. D.

II.

Whatever the path described by a moving point, the direction of its motion at any instant is that of the tangent to that path, at the position occupied by the point at the given instant.

The law of the motion, even in abstract mathematics, may often be best explained by describing it as dependent upon and produced by other motions: thus for example a spiral of any kind is usually defined as the path of a point which travels along a right line, while the line itself revolves about a fixed centre.

And "Roberval's method" of drawing a tangent to a curve, consists simply in finding the resultant of these component motions. A simple illustration of this method is shown in its application to the spiral of Archimedes, Fig. 12. Let a point move at a uniform rate from P along the right line PQ, while that line revolves in the direction of the arrow around P as a fixed centre, also at a uniform rate. Let the radial travel be such that while making one revolution the point shall move from P to A, then it will trace the curve $PEFAG$; and let it be required to draw a tangent at the point O. The two motions might be supposed to take place independently; if we first imagine the rotation to be arrested, the point will move, in the time of one revolution, radially outward through a distance ON equal to PA: and we may therefore let ON represent the velocity of this component. If we suppose the radial motion to be arrested, then in the same time the point will describe the circumference of the circle of which PO is the radius. The direction of this motion at the instant being that of the tangent to the circular path, we have as the other component, OM perpendicular to PO, and equal in length to the

circumference; then completing the rectangle, the diagonal OR is tangent at O to the spiral, as required: obviously, both components may be reduced in the same proportion, without affecting the direction of the resultant, which is of course independent of the actual velocity of the tracing point.

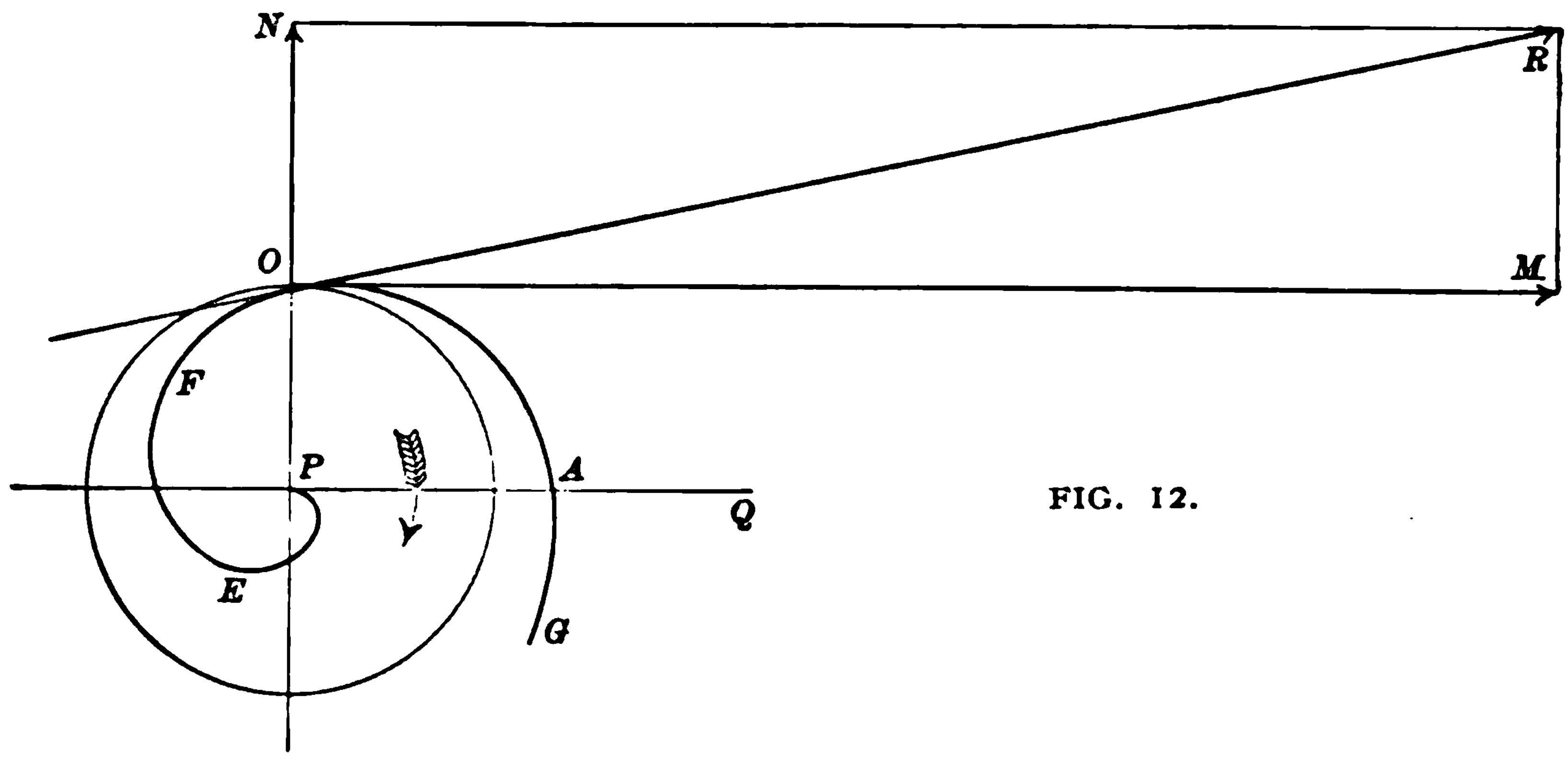


FIG. 12.

Since $\frac{NR}{ON} = \tan, NOR$, the inclination of the tangent to the radius vector can be determined by elementary trigonometry; and in its application to many other curves, of high and low degree, a like simplicity characterizes this elegant process. Nevertheless, in his treatise on Descriptive Geometry, Mr. J. F. Heather makes this curious remark: "This method, which Roberval invented before Descartes had applied algebra to geometry, is implicitly comprehended in the processes of the differential calculus, on which account it is not noticed in elementary mathematics";—where it would seem on the contrary to deserve a conspicuous place: it is certainly more easily comprehended than the calculus, to which indeed it is a natural prelude. At any rate, it has a natural and direct application to our present purpose, since in mechanical devices the actual motion of a point is, more often than not, controlled by other motions whose combined effect it is necessary to determine.

But in applying it, all the dircumstances of the case must be considered, and all the conditions which may affect the result must be satisfied. This suggestion may at first glance appear superfluous; but it seems otherwise in view of the fact that Mr. Heather, in the only illustration of Roberval's method which he gives, has conspicuously failed to act upon it. The curve selected for this solitary example is the ellipse, traced as in Fig. 13 by a point *P*, moving in such a manner as to keep always taut a thread *APB*, attached by its extremities to the foci *A* and *B*. Mr. Heather's explanation is as follows: "Since the length of the string is constant, the distance *AP* is lengthened at each in-

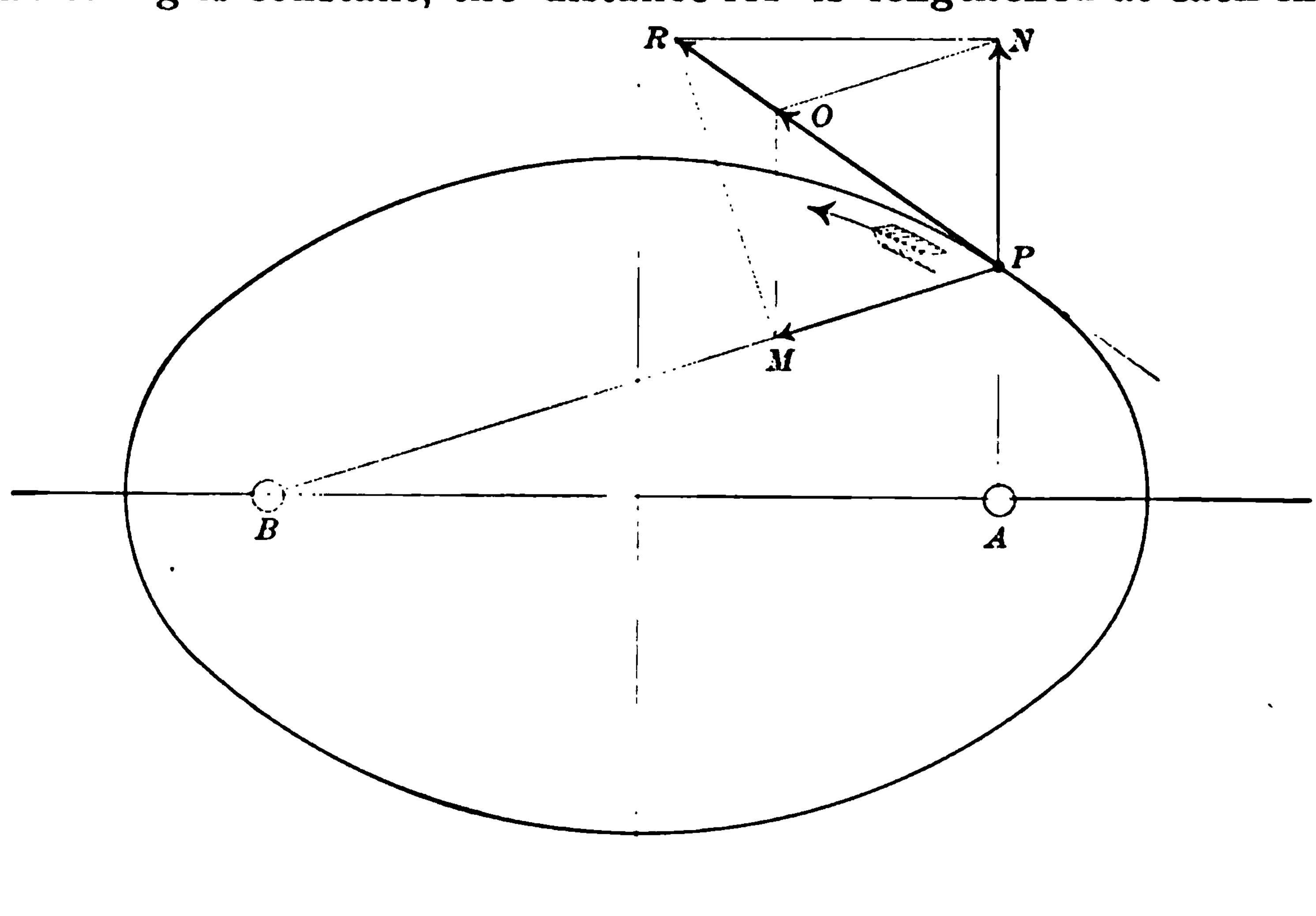


FIG. 13.

stant of the motion by the same distance as the distance *BP* is diminished. The velocity of the describing point in the direction *AP* is therefore equal to the direction in the direction *PB*. If, then, equal straight lines be cut off from *PB*, and from *AP* produced, and the parallelogram *PNOM* be completed, the diagonal *PO* of this parallelogram will be the direction of the motion of the generating point at *P*, and consequently the tangent to the

curve at this point. It is clearly seen from this, that in the ellipse the tangent bisects the angle BPN, formed by one of the focal distances and the production of the other," etc., etc.

Mr. Heather elsewhere explicitly states that if the components in two directions are given, whatever their relative magnitudes, the method of Roberval consists in "completing the parallelogram and drawing the diagonal." In the above example the *direction* of the tangent is, undeniably, correctly found in this manner—and the same is true if this construction is applied to the hyperbola, in which the moving point recedes from both foci at the same rate, or to the parabola, in which it recedes at the same rate from the focus and the directrix.

In all these cases however the components are *equal;* but the statement above quoted leads us to expect a correct determination whether they are equal or not: let us put it to the test. In Fig. 14, let A and B be two fixed points, with reference to which the point P moves subject to the condition that PB shall always be twice PA. In other words, the path of P is the locus of the vertices of all triangles of which AB is the common base, and one of the two other sides is twice the third. In order to preserve this ratio, it is clear that P in moving to the right must re-

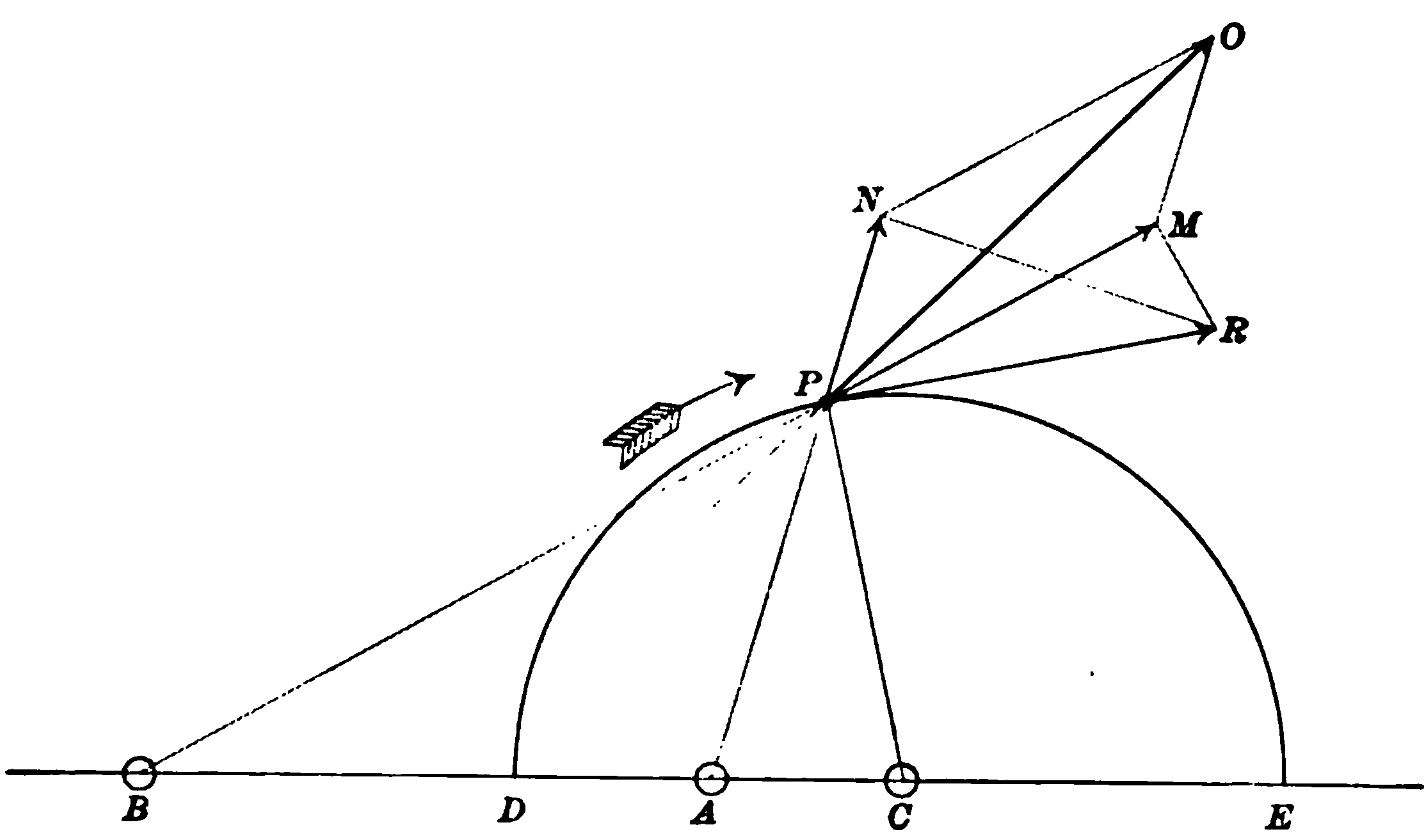


FIG. 14.

cede from B twice as fast as it does from A. Consequently, setting off on the prolongations of BP and AP, $PM = 2\,PN$, and completing the parallelogram, the diagonal PO should, in accordance with what immediately precedes, be the required tangent. But it can be shown that the path in question is the circumference of the circle whose diameter is DE, determined by making $BD = 2\,AD$, and $BE = 2\,AE$. It is obvious that PO is *not* tangent to this circle, and therefore cannot be the resultant motion of P.

A little reflection will show that two important conditions have been neglected: the point P lies upon the right line PA, and must always do so; therefore if that point moves as shown, the line must turn about A as a fixed centre; and similar reasoning applies to the line PB. Thus the situation is in fact more complicated than it seemed at first, and really presents a special case of the general problem of determining the motion of the intersection of two right lines rotating about fixed centres; which therefore must next receive attention. The elements of this problem are embodied in the mechanical combination shown in Fig. [illegible], where [illegible] represent two steel rods, each formed into an eye at one end, and turning about the fixed pins [illegible]; upon these rods two sleeves slide freely, and they are pivoted together by a pin at P, whose axis, perpendicular to the paper, intersects the centre lines of both rods.

The operation of this device may perhaps be best studied by first supposing one rod, as [illegible], to be held stationary while BD turns. The point [illegible] of that rod must then at the instant move in a direction perpendicular to [illegible]; let its velocity be represented by [illegible]. The pin connecting the sleeves must move absolutely in the direction [illegible], since the rod [illegible] now forms a fixed guide, along which the sleeve, through which it passes, is compelled to slide. The other sleeve however not only rotates with BD, but can slide along that rod; consequently the actual velocity [illegible] of the pin P is found by drawing through [illegible] a parallel to

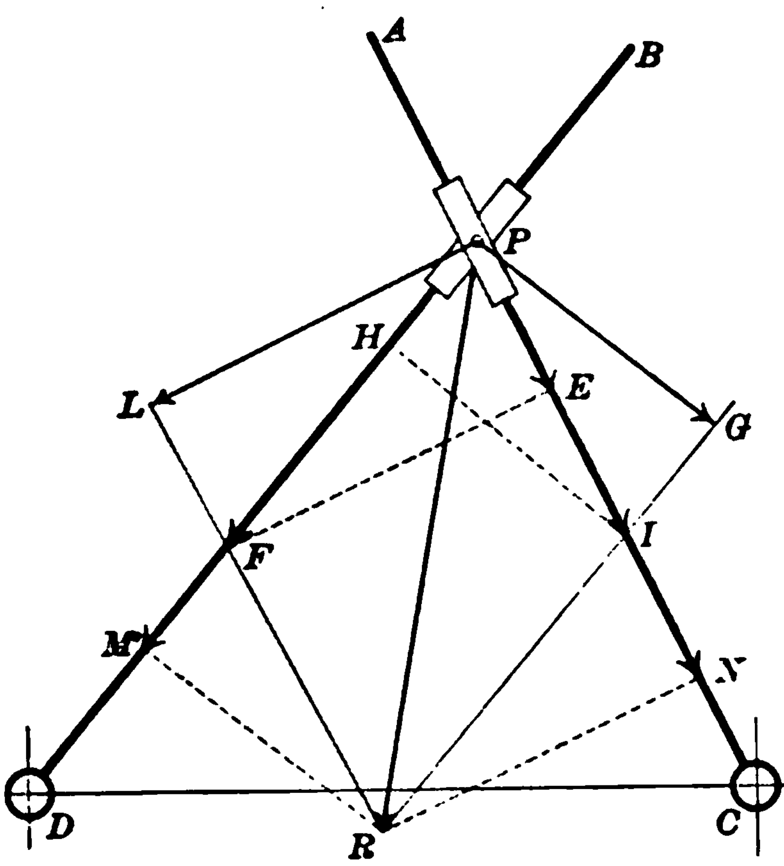


FIG. 15.

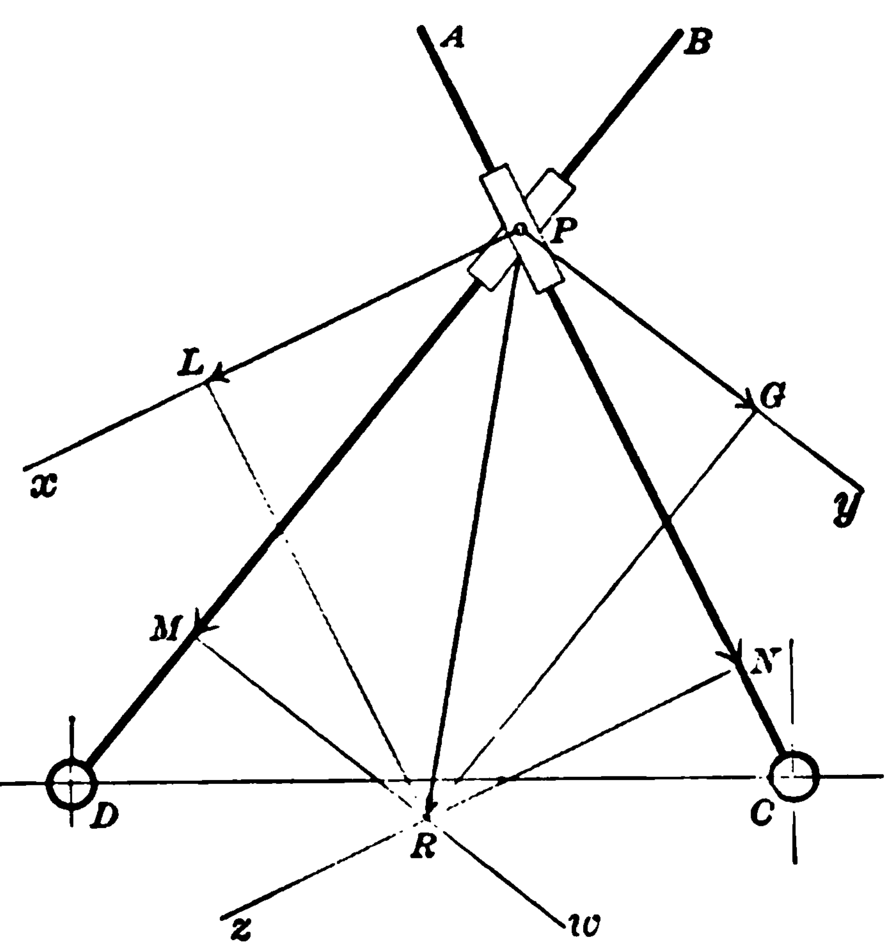


FIG. 16.

BD. Drawing *IH* parallel to *PG*, we observe that upon the supposition above made, the pin *P* moves in the direction *AC* at the rate *PI*, and in the direction *BD* at the rate *PH*.

Next let *BD* be held stationary, and let the point *P* of the rod *AC* move in rotation about *C* with the velocity *PL*. By similar reasoning we shall find the resultant motion of the pin *P* to be *PF* in the direction *BD*, and it will be accompanied by a motion *PE* in the direction *AC*.

Now if both rods rotate at once, with the same velocities as before, the final resultant motion *PR* of the pin *P* is found by considering the partial resultants *PI*, *PF*, as components, and completing the parallelogram; because, as we have just seen, these are wholly independent of each other. But it is to be noted that *P* will move toward *C* with a velocity equal to $PI + PE$, and toward *D* with a velocity equal to $PF + PH$. Drawing *RM* perpendicular to *BD*, and *RN* perpendicular to *AC*, we have $FM = PH$, and $IN = PE$: so that *PM*, *PN*, are the velocities of *P* in the directions *BD*, *AC* respectively.

Also, since *FR*, *IR*, are merely prolongations of *LF* and *GI*, it will be seen that having assigned the components of rotation,

PG and *PL*, the resultant *PR* may be at once determined by drawing perpendiculars to them, which will intersect in *R*: then drawing *RM* and *RN*, we determine *PM* and *PN*, the total sliding components.

If then as in Fig. 16 the components *PN*, *PM*, are assigned, the resultant is found, not by completing the parallelogram, but by drawing *Nr*, *Mx* respectively perpendicular to *AC* and *BD*; these intersect in *R*, and *PR* is the resultant. Had this resultant been assigned, the sliding components are found at once, as above stated, by reversing this process; and the components of rotation are determined as readily, by drawing *Px* perpendicular to *AC*, and *Py* perpendicular to *BD*, upon which lines we let fall from *R* the perpendiculars *RL*, *RG*.

This, then, is the proceeding which should have been adopted in Figs. 13 and 14. Applying it in those cases, we find the resultant motion of the point *P* upon the ellipse to be *PR* instead of *PO*; the direction is the same, but the magnitude is different, and plainly will be so except in the case when *PA* and *PB* are perpendicular to each other. And in Fig. 14, it is seen that the direction as well as the magnitude of the true resultant *PR* is widely different from that of *PO*; moreover, it can be proved that *PR* is in this case perpendicular to the radius *PC*, and therefore tangent, as it should be, to the circular path *DPE*.

The manner of determining the resultant, when the components *PM*, *PN*, Fig. 16, are assigned, is in this case precisely the same as that employed in Fig. 6. But the conditions are by no means the same; in that instance the lines along which the given components lie intersect always in the same point *A*, whereas in this the point of intersection moves along both lines; and they both clearly illustrate the fact that Roberval's method does not always consist in merely completing the parallelogram and drawing the diagonal.

(To be continued.)

TEST OF NASH GAS ENGINE WITH DIRECT-CONNECTED DYNAMO.

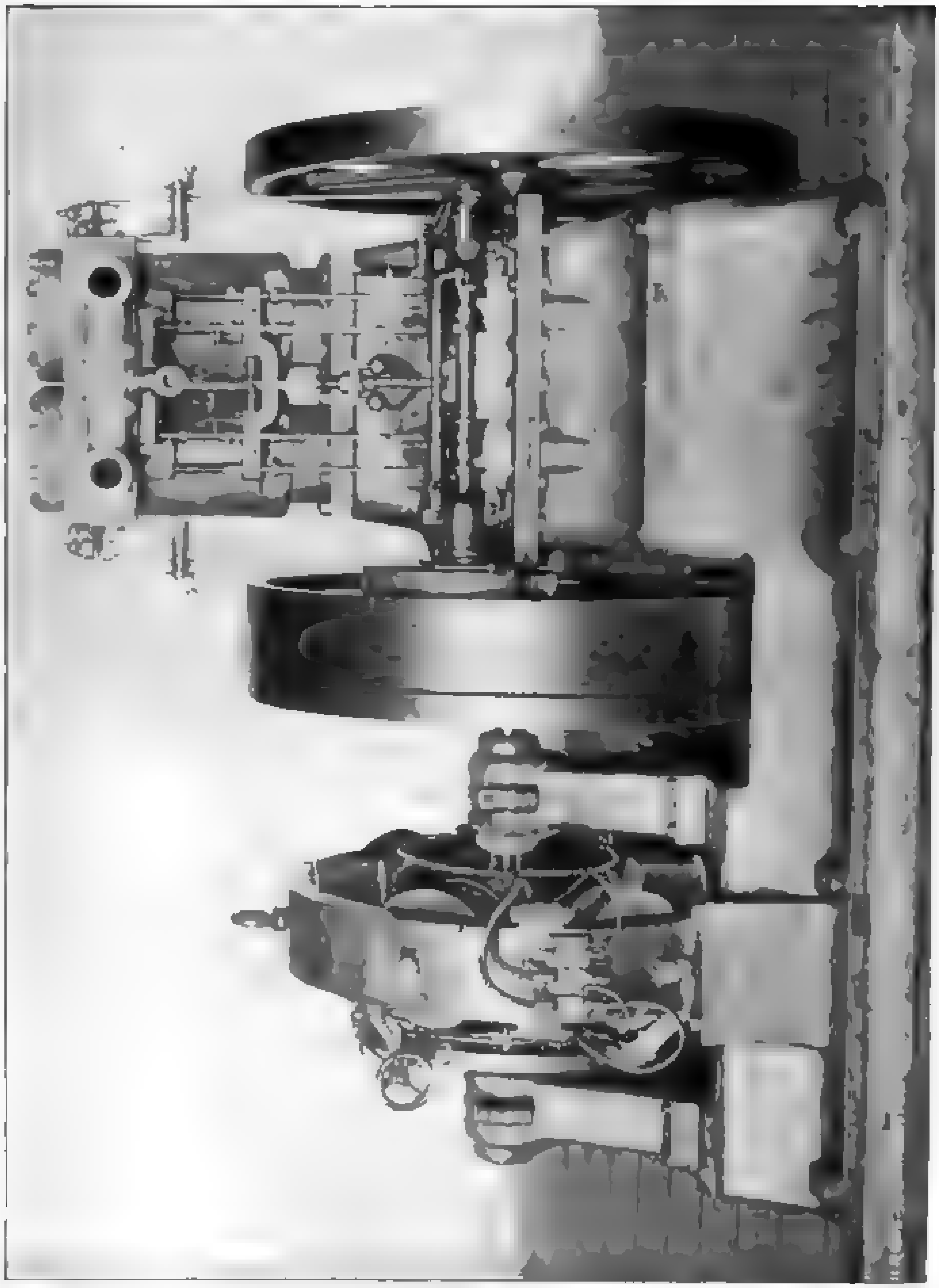
GRADUATION THESIS, 1897, BY FRED OPHÜLS, WILLIAM I. THOMPSON AND H. DONALD TIEMANN.

DESCRIPTION OF PLANT.

The plant tested is one that was presented to Stevens Institute of Technology by members of the Board of Trustees, the Faculty, and the class of '97, aided by a large reduction in price on the part of the builders. It is located in the Electrical Laboratory. It consists of a 20 H. P. Nash Gas Engine coupled by means of a friction clutch to a Riker dynamo. See Fig. 1.

The engine is of the vertical type. The base is a heavy casting forming an enclosing case in which are placed the crank shaft, bearings, and connecting rods, all of which are run in oil and are accessible through a large door. There are two single-acting cylinders entirely independent of each other with cranks set at 180° apart, so that two explosions occur in alternate revolutions. The governor is a simple disengagement-governor, one rod being set slightly in advance of the other, thus allowing, at times, an admission in one cylinder only, which renders the governor more sensitive. The valves are of the plain poppet type and are actuated by hardened steel cams on a counter-shaft making one-half the revolutions of the main shaft. On this counter-shaft are also the two eccentrics for operating the electric igniters, the time of explosion being regulated by the position of the eccentrics. Besides these there are hot-tube igniters, consisting of tubes heated red-hot by Bunsen burners.

The gas is admitted to the engine by an adjustable check valve, Fig. 2. It passes up through a circular hole in the valve seat, over which rests a flat washer which acts as a check to the return flow of the gas. As the gas passes through, it lifts the washer from its seat, the amount of lift being regulated by the screw-cap of the valve. The rim of this cap is indexed, so that its position may be noted and the flow of gas regulated.



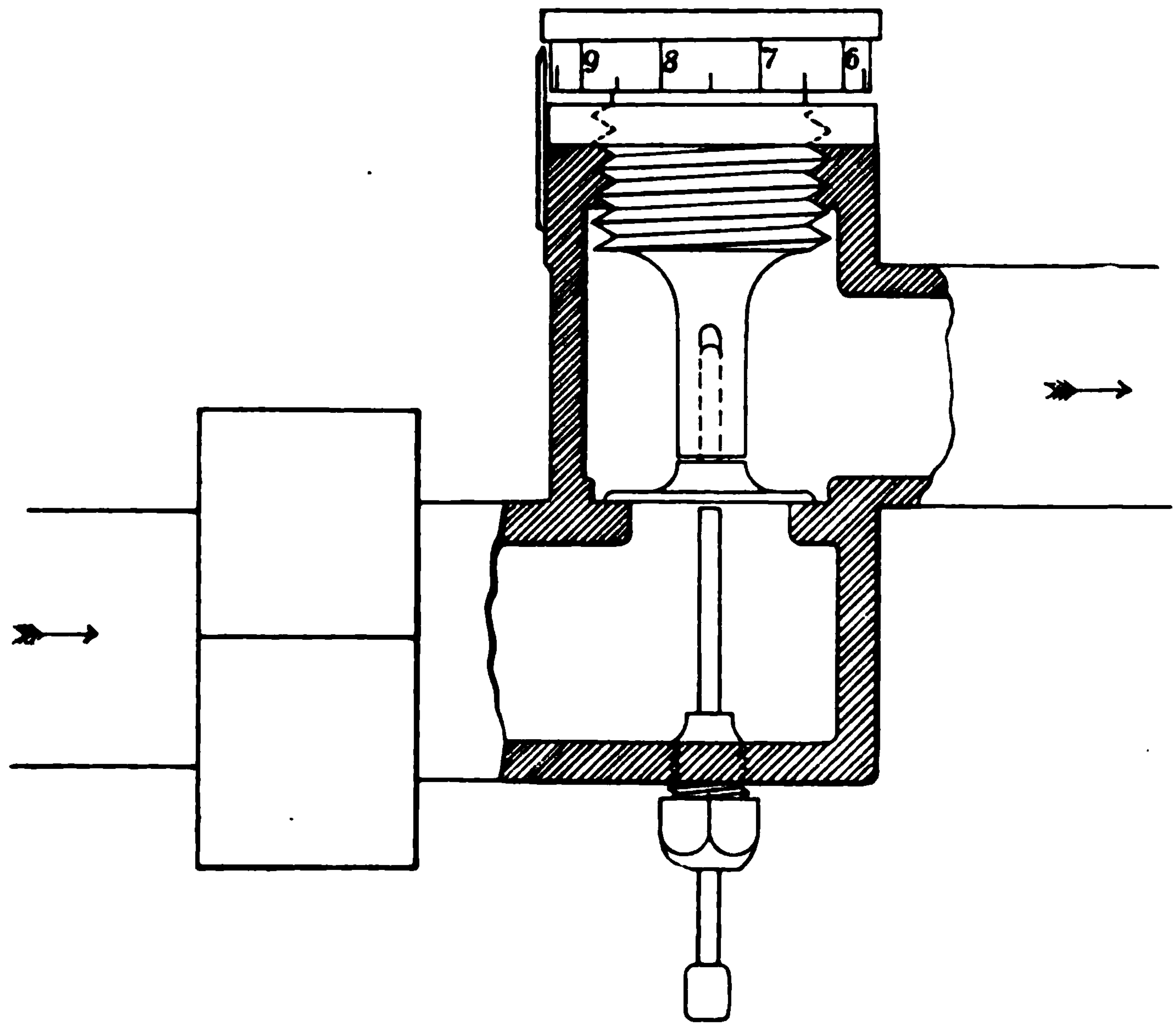


FIG. 2.

The dynamo is a six-pole compound wound machine built by the Riker Electric Motor Co., of New York ; it is rated at 125 volts, 120 amperes, and 300 revolutions.

In order to secure as nearly a uniform speed as possible for the dynamo it is not fixed directly upon the shaft of the engine, but is coupled by means of a friction clutch. This consists of three separate wheels ; the engine fly-wheel, upon the inner surface of which the friction shoes act ; an intermediate fly-wheel, which is not fast to either shaft, and a smaller inner wheel which is fixed to the shaft of the dynamo. When the engine speeds up suddenly, the two shoes attached to the intermediate wheel are thrown off by the centrifugal force of two weights, thus allowing this wheel to lag. The lag, by a system of links, in turn loosens the four shoes connected to the dynamo wheel, thus disconnecting, to a degree, the dynamo from the engine. As the dynamo has less momentum than the intermediate fly-wheel, especially when running under a load, it will immediately tend to lag behind this wheel, the effect of which is to tighten the shoes of the

dynamo wheel against the engine fly-wheel until its speed is brought up to that of the intermediate wheel again. As the intermediate wheel loses momentum it moves again tighter to the engine wheel and its momentum is restored. Thus the speed of the dynamo is controlled by the action of this intermediate wheel.

SYNOPSIS OF TESTS.

1. Comparison of illuminating power obtained from gas when burned directly and when used in engine to produce incandescent electric lights.

Most efficient conditions for running engine.

2. Tests of electric output.
3. Photometry.
4. Friction of engine and dynamo.
5. Prony brake test of engine.

DESCRIPTION AND ARRANGEMENT OF APPARATUS.

The gas for the engine was measured by a 100 light meter made by John J. Griffin & Co. of Philadelphia, and that for the igniters by a small 5 light meter made by the American Meter Co. of Philadelphia.

The number of admissions of gas was registered by a recording device, electric contact being made every time either admission [illegible] was opened. Samples of the tape are shown in Fig. 3.

The revolutions of the engine and dynamo were recorded by [illegible] counters.

SAMPLES OF RECORD TAPE SHOWING NUMBER OF ADMISSIONS.

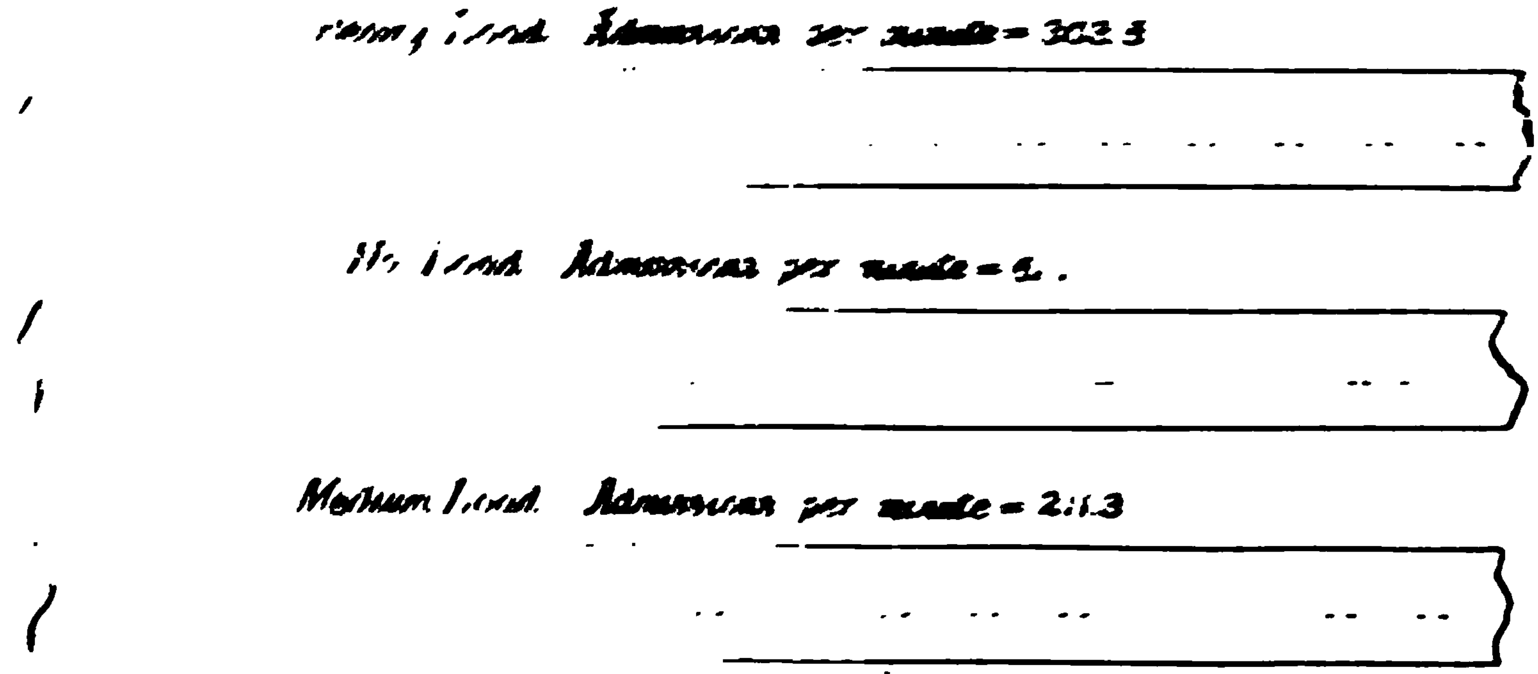


FIG. 3.

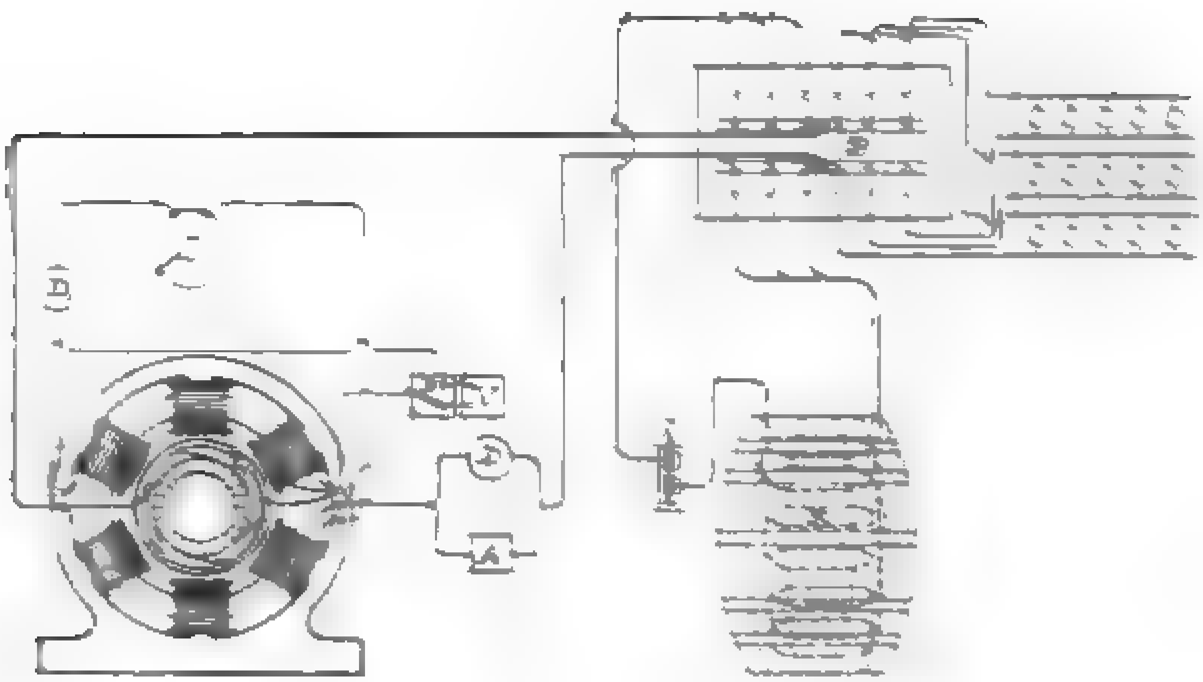


FIG. 4

The jacket water was measured in two calibrated barrels.

Fig. 4 shows the general arrangement of the electric circuit. The power was distributed from two buss bars, B, through fuse wires, part being absorbed by incandescent lamps and the remainder in a water rheostat, R. The external current was measured by an ammeter A, and a dynamometer D in parallel, and the current in the shunt field by a dynamometer D_1. The voltmeter V was so connected that the volts could be measured both across the brushes directly and across the terminals of the external circuit by changing the switch S. The instruments A, D, and V, were placed about 20 feet from the dynamo so as to insure their being out of any field. The ammeter A, showed no error and the voltmeter V, showed a possible error of 0.2%. The dynamometer D, was not tested for field, but as its position was similar to the ammeter A, it is fair to presume that it, also, was not affected. The dynamometer D_1, was affected by a field to the extent of 4%. Since the instruments were always placed in the same positions, any errors due to field may be neglected in the comparative tests where the load is not very different.

The water rheostat was made of about 40 feet of No. 14 B. & S. german silver wire, wound upon a wooden frame and immersed in a barrel of running water. It absorbed between 9,000 and 10,000-watts.

DESCRIPTION OF TESTS. TEST I.

1. Before comparing the illuminating power of the gas and electric light, it was of the greatest importance to ascertain the conditions under which the maximum output was obtainable for the least consumption of gas. The most natural element to vary with this end in view, after setting the brushes of the dynamo in the best position, is the amount of gas admitted with the air to each cylinder, which is regulated by the position of the gas valve as before explained. The air pipe, as set up, was [illegible] feet long with two bends and ended directly over the two exhaust ports. Seven fifteen minute tests and five one hour tests were made with different positions of the gas valve. The results of these tests were so unsatisfactory that they led to the supposition that at times the exhaust gas was sucked into the air pipe. The pipe was therefore extended [illegible] feet horizontally in order to obtain pure air. With this arrangement, however, the engine could not get enough air to run under a load. The pipe was then shortened to [illegible] feet so that the air was taken from the room, and a short test made which gave a remarkable increase in the efficiency. It was decided to make tests for the best length of air pipe, varying the position of the valve for each length. Forty-three (43) twenty minute and five (5) fifteen minute tests were made. In all these tests the temperature of the jacket water was kept the same as nearly as possible.

2. Having thus determined these two factors, two four hour tests for the electric output were made, one with a medium load, the other with the greatest load the engine would carry.

The method of carrying out these tests was as follows: Readings were taken every [illegible] minutes in the fifteen minute tests, every [illegible] minutes in the twenty minute tests, and in the long four hour tests, every [illegible] minutes. The readings taken regularly were:

Gas Meter.
Temperature of Gas.
Pressure of Gas.
Temperature of Room.
Field Current.
External Current.

Volts across the Brushes.
External Volts.
Revolutions of Engine.
Revolutions of Dynamo.
Quantity of Jacket Water.
Temperature of Jacket Water.

The admissions were taken often enough to obtain a reliable average. The barometer readings were also taken.

The energy absorbed in the field was considered with the external output, before comparing the results of the preliminary tests.

All volumes of gas were reduced to 30" Hg. and 60° F. by means of table Pg. 212, Vol. 13, of the STEVENS INDICATOR.

The calorific power of the gas was determined by means of the Junker Calorimeter.

3. The photometer used was a Bunsen Photometer. In order to avoid any differences in the illuminating power of the gas, all the photometric measurements were made on one day. The gas flames and the electric lamps were each compared with an Argand burner, which was first standardized by means of spermaceti candles. In standardizing this burner, all tests were rejected in which the two candles did not burn at the rate of 40 grains in from $9\frac{1}{2}$ to $10\frac{1}{2}$ minutes. The candle power of the standard burner did not affect the *relative* candle powers of the lights compared. Therefore any error in finding the candle power of the burner by means of the candle may be neglected.

The lights compared were,—six electric lamps, and a 3-foot, 4-foot and 6-foot gas burner. They were measured at various angles, the average of these readings at each angle being taken. The gas was measured by a 5-light American Gas Meter, and the readings were reduced to 30" Hg. and 60° F., by table Pg. 212, Vol. 13, of the STEVENS INDICATOR.

TEST B.—FRICTION OF ENGINE AND DYNAMO.

The method of finding the friction was to drive the engine and dynamo with no load by means of a separate motor belted to the engine pulley, and afterwards to calibrate the motor by a Prony Brake under the same electric conditions. The currents for the field and armature were supplied by separate machines,

the belt current remaining nearly constant during the tests. The mechanical friction of the engine could not be found with the cylinder heads on, for the engine acts as an air pump. One test was made with the heads on and one with the heads off, the revolutions of the engine being the same as when running itself.

[illegible] PRONY BRAKE TEST OF ENGINE.

For this test the dynamo was disconnected and the consumption of gas per brake H. P. was determined for the heaviest load.

In order to determine the most efficient air pipe length and valve position, forty-one hour tests with a [illegible]-foot pipe and forty-eight comparative tests on various air pipes and valve positions were made.

The best conditions were determined to be [illegible] foot pipe and 7½ valve position, which are therefore used in all following tests.

Two four-hour tests were made to determine the gas consumption per kilowatt per hour which was found to be for a medium load.

33.12 cu. ft. not including gas for igniting burners and

33.99 cu. ft. including gas for igniting burners.

and for a heavy load

30.25 cu. ft. not including gas for igniting burners and

30.83 cu. ft. including gas for igniting burners.

STANDARDIZATION OF ARGAND GAS BURNER WITH EDGERTON SLIT, USED FOR MEASURING CANDLE POWER OF GAS FLAMES AND ELECTRIC LIGHTS.

The candle power of the candles was calculated by the formula;

$$\frac{\text{Candle Power}}{2} = \frac{150 \text{ seconds}}{\text{Time required to burn 10 grains, in seconds}}$$

in which 150 seconds is the standard time for 2 candles to burn 10 grains when giving 1 candle power each, which corresponds to 1 candle burning at the rate of 2 grains per minute.

x = distance in inches from standard Argand burner to screen.

$100 - x$ = distance in inches from candles or gas flame to screen.

The candle power of the burner was calculated by the formula;

$$\frac{\text{Candle power of Burner}}{\text{Candle power of Candles}} = \frac{x^2}{(100 - x)^2} \text{ and was found to be 6.4.}$$

The candle powers of the gas flames were calculated by the formula;

$$\frac{\text{Candle Power of Flame}}{6.4} = \frac{(100 - x)^2}{x^2}$$

The candle power was measured for the flame in twelve positions 30° apart, the position when the flat side of the flame was toward the screen being called 0°.

TESTS OF ELECTRIC LAMPS.

The candle power of the electric lamps was measured in six positions 60° apart, the position when the loop of the filament was parallel to the screen being called 0°.

x = distance in inches from standard Argand burner to screen.

$100 - x$ = distance in inches from lamp to screen.

$$\frac{\text{Candle Power of Electric Lamp}}{6.4} = \frac{(100 - x)^2}{x^2}$$

where 6.4 = candle power of standard Argand burner.

EXPLANATION OF TABLE I—COMPARISON OF LIGHT.

Table I gives the final results, in the tests for the relative amounts of illumination given by electric lights and the gas required to produce those lights. For a heavy load, new electric lamps give 2.21 times as much light as the gas used by the engine would give, medium lamps, 1.69 times as much and old lamps only 1.26 times as much. With a medium load the figures are 2.00 for new lamps, 1.54 for medium and 1.14 for old lamps.

Six tests were made to determine the calorific power of the gas used, which was shown to yield 701.3 B. T. U. per cubic foot.

The friction of the engine and dynamo was determined by driving them with a motor connected to the engine pulley. The friction, with the cylinder heads off, was found to be 3.83 H. P., and with the heads on, 4.98 H. P., showing that 1.15 H. P. was used in pumping air.

TABLE I.

CANDLE POWER OF GAS.				CANDLE POWER OF ELECTRIC LAMPS.					
Kind of Burner.	Gas per hour, cu. ft.	Candle Power.	C. P. per cu. ft. per hour.	Condition of Electric Lamps.	Watts.	Candle Power.	Watts per C. Power.	Average.	C. P. per Kilowatt.
6	5.39	28.62	5.31	New	61.3	16.12	3.803	3.66	273.2
4	4.05	14.72	3.634	"	62.0	16.57	3.742		
3	2.94	9.08	3.088	"	59.4	17.27	3.44		
				Medium	49.6	10.45	4.75	4.77	209.6
		Average=	4.01	"	58.1	12.15	4.78		
				Old.	48	7.47	6.42	6.42	155.8

		Medium Load		Heavy Load	
		Not including gas for igniting burners.	Including gas for igniting burners.	Not including gas for igniting burners.	Including gas for igniting burners.
1. Gas per Kilowatt per hour.—cu. ft.		33.12	33.99	30.26	30.84
2. C. P. of Gas required to produce 1 Kilowatt = 1 × 4.01		132.8	136.3	121.3	123.7
3. Ratio of light for same amount of gas consumed with flat flame gas burner.* Electric / Gas	New electric lamp	2.06	2.00	2.25	2.21
	Medium " "	1.58	1.54	1.73	1.69
	Old " "	1.17	1.14	1.28	1.26

The result of a one-hour test for the gas consumption, with no load on the dynamo, showed 95.2 cu. ft. per hour.

A Prony brake test was made with a view to showing the consumption of gas per hour per brake H. P., which was found to be 17.62 cu. ft., including the gas used to ignite the burners, and 17.37 cu. ft. *not* including the gas used to ignite the burners.

EFFICIENCY OF DYNAMO.

The tests compared in the following table are a 4-hour test on the electric output and a ¾-hour test on the brake H. P.

* This ratio is the candle power of light emitted by the electric light to the candle power of the gas when burned in a flat flame burner. The ratios are greater than unity which shows that there is more light generated by the electric system for a given amount of gas, than by burning the gas in a flat flame burner.

LOAD.	Corrected Gas per hr.	Watts.	H. P.	% Slip.
Electric	397.1	13125	17.59	7.01
Brake	394.5		22.71	

From curve of watts and gas for loads of 10.1, 8.7 and 13.1 Kilowatts the number of Kilowatts corresponding to a gas consumption of 394.5 cu. ft. is 12.97.

If $a =$ total power delivered by engine to friction clutch,
$y =$ efficiency of dynamo including friction,
$b =$ fraction of total power lost in friction clutch,
$p =$ external electric H.P.,

Then $y = \dfrac{p}{a\,(1-b)}$

$$12.97 \text{ Kilowatts} = 17.39 \text{ H.P.} = p$$

$$\therefore y = \frac{17.39}{22.71(1-.0701)} = \frac{17.39}{22.71 \times .9299} = .831$$

EFFICIENCY OF ENGINE.

Taking the gas per hour per brake H.P. = 17.62 cu. ft., and the calorific power of the gas per cu. ft. as 701.3 B. T. U., the efficiency of engine $= \dfrac{60 \times 33000 \times 100}{17.62 \times 701.3 \times 778} = 20.6\%$

CONCLUSION.

The results of the tests are as follows:—

First.—Best length of air pipe = 3 feet.

Second.—Best position of gas valve = 7½.

Third.—Gas per K.W. per hour (full load) = 30.83 cu. ft.

Fourth.—The amount of light given by electric lamps which have been in use some time is 1.69 times as much as light which the gas used to drive the engine would give if burned directly in burners.

Fifth.—Calorific Power of Gas = 701.3 B. T. U.

Sixth.—H.P. lost in friction of engine and dynamo = 3.83 = 13.8% of total H.P.

Seventh.—H. P. lost in pumping air = [illegible] = [illegible] of total H. P.

Eighth.—Prony Brake H. P. = 22.71.

Ninth.—Gas per brake H. P. per hour = 17.62 cu. ft.

Tenth.—Gas per hour to drive engine and dynamo (no load) = 35.2 cu. ft.

Eleventh.—Efficiency of engine = 20.6%.

Twelfth.—Efficiency of dynamo = 83.1%.

ON DETERMINING THE MOISTURE IN STEAM.

BY PROFESSOR D. S. JACOBUS.

Many inquiries come to me in regard to the best method of determining the moisture in steam. This subject has been treated in several papers which have been read before the American Society of Mechanical Engineers, by Professor Denton and myself,* and in my discussion of a paper presented by Messrs. Goubert and Peabody, at a meeting of the same society.

It is the object of the present paper to describe a special method of obtaining a sample of steam, and to state briefly the best way of employing throttling calorimeters in determining the moisture contained in steam.

The results of the investigation on which the papers already referred to were based proved, that the ordinary form of perforated collecting nipples were not reliable for use in gleaning the average sample of steam from the entire mass flowing through a steam main. It was also shown that in a horizontal pipe of sufficient length, and for the velocities of steam which occur in ordinary practice, the water collected at the bottom, and ran along in a small stream, which could be wholly drained out in most cases by means of a small drip-pipe leading from the bottom of the pipe.

These tests were made as preliminary to an investigation undertaken for the Babcock and Wilcox Company, by Professor Denton, to determine the conditions under which throttling

* Results of measurements to test the accuracy of small Throttling Calorimeters, Transactions A. S. M. E., Volume XVI, page 448.

Tests to show The Distribution of Moisture in Steam When Flowing through a Horizontal Pipe, Transactions A. S. M. E., Volume XVI., page 1017.

The Reliability of "Throttling Calorimeters." Transactions A. S. M. E., Volume XVII., page 175.

Discussion: Some Experiments with the Throttling Calorimeter, by A. A. Goubert and E. H. Peabody, Transactions A. S. M. E. Volume XVII., page 182.

calorimeters, applied to a steam main, are a reliable means of determining the average amount of moisture in the total quantity of steam flowing through it.

The results of the experiments show that all that can be done with certainty in determining the quality of a large mass of steam flowing through a main, by gleaning out a small sample of steam and passing it into the calorimeter, is to ascertain whether the steam is practically dry, or whether there is a considerable amount of moisture present. It is impossible to ascertain with certainty the exact percentage of moisture, unless the entire mass of steam flowing through the main is dealt with. If the entire mass of steam is passed through a separator, and the steam leaving the separator is found to be dry, then we can determine the amount of moisture in the steam by weighing the water drawn from the separator. The entire mass of steam can also be throttled, and the temperature measured after throttling, which would be equivalent to passing the entire mass of steam through a throttling calorimeter, and from this temperature the moisture could be accurately determined. We have employed this latter method in boiler tests with satisfactory results, but ordinarily the steam cannot be wasted, and such a method cannot be used.

Another way of determining the moisture for the entire mass of steam is to attach a drip-pipe to the bottom of a horizontal main, at such a distance from an elbow, or bend, that the water will have time to fall from the steam and collect, and run along the bottom of the pipe in a small stream, and to draw out the moisture through the drip-pipe instead of collecting it by means of a separator. If the steam beyond the drip-pipe is found to be dry, then the percentage of moisture may be found by weighing the amount of drip water. It is a method based upon this principle, which it is the special object of this paper to describe. We have obtained reliable data in employing it, and there are advantages possessed over other methods which will be pointed out.

Three Barrus throttling calorimeters were employed, connected as shown in Fig. 1. The calorimeter *A* was attached to the separator *G* and the separator *G* was in turn attached to the bottom of the pipe by means of the nipple *D*, the end of which was made flush with the inside of the pipe. The calorimeter A was run continuously and any water running along the bottom of the pipe flowed into the nipple *D* and was removed by the separator *G*. The calorimeter *B*, was attached to a nipple with no side holes, which could be forced in and out of the stuffing box *E*, by means of the screw *N*.

A sample of steam could thus be obtained from any section of the pipe, and led to the calorimeter *B*. The calorimeter *C* was attached to the perforated nipple *F*, which extended nearly to the top of the pipe. If the calorimeter *B* indicates dry steam for all positions of the adjustable collecting nipple in the steam main then the steam passing it is dry and any moisture in the steam has been drawn out by the drip-pipe and collected in the separator *G*. The calorimeter *B* will sometimes indicate dry steam for all positions except when the adjustable nipple is lowered so as to drain out any moisture there may be directly at the bottom of the pipe. If this is the case the moisture which enters it may be caused by the radiation of the length of the main steam pipe between *D* and *E*, or by the small amount of water which may not be removed by the nipple *D*.

If when the nipple is at the lowest position there is any superheating shown by the thermometer *I*, that is, if the thermometer registers a temperature of over 212° F. and at all positions of the adjustable nipple the thermometer is high enough in its readings to indicate dry steam, it is safe to assume that the moisture which enters the nipple when at the lowest position is from one of the above causes, and to consider that practically all the moisture in the steam has been drawn out through the nipple *D*.

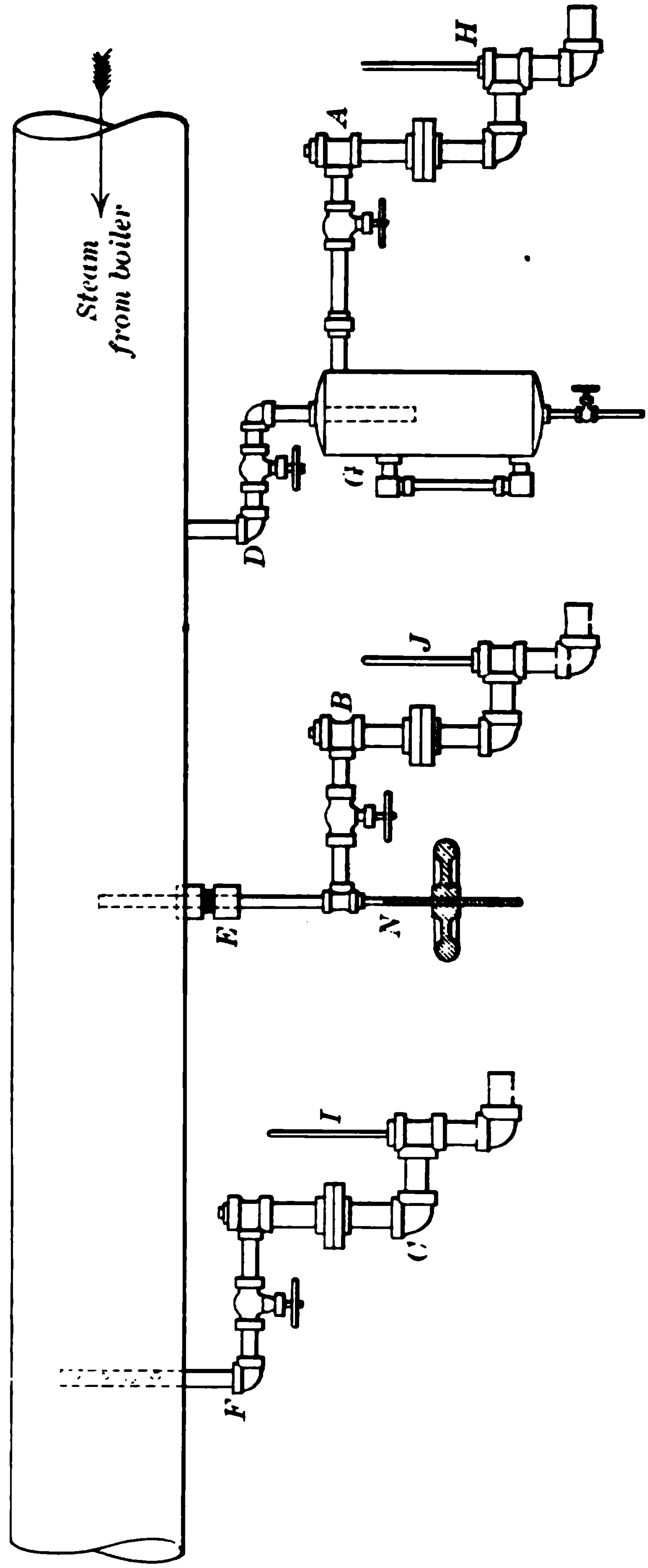


FIG 1.

The calorimeter *C* connected to the perforated nipple *F* serves to show that there is no moisture distributed through the steam and in case of a sudden belch of moisture it would indicate the same.

The lowest hole in the perforated nipple *F* is made about three-eighths of an inch above the bottom of the pipe.

If the steam in the pipe is dry, or practically dry, there will be no water, or very little water, collected in the separator *G*, and the calorimeters *B* and *C* will indicate dry steam. If there is moisture drawn from *G* and the calorimeters *B* and *C* indicate dry steam then the percentage of moisture may be obtained by weighing the water drawn from the separator *G*.

We cannot measure the amount of moisture closer than about one-fifth of one per cent. with throttling calorimeters because we have to calibrate the throttling calorimeters to determine the normal reading, or the reading thermometers for dry steam, and we can vary the quality of what may be called dry quiescent steam to an extent that will cause a variation in the normal reading of 3 degrees Fahr. which is equivalent to about one-fifth of one per cent. of priming.*

This difficulty does not disappear if the theoretical formula is used where the normal reading need not be determined by experiment.

If therefore the steam is found to contain one-fifth of one per cent. of moisture, or less, it may be called dry steam, for the determination is within the limit of error ; if, on the other hand, the determination by a throttling calorimeter shows slightly superheated steam, to the extent of about 3 degrees Fahr., it may be due to this same cause and again the steam may be simply dry steam.

In other words, the quality of the dry steam, which is our standard of measurement, may vary to the equivalent of about

* Transactions A. S. M. E., Volume XVI, pages 460 and 1036.

one-fifth of one per cent. of priming and the absolute results are liable to be in error by this amount.*

The Separator *G* combined with the calorimeter *A* forms a Barrus Universal Calorimeter† and experiments have shown that with a properly constructed separator the steam passing into the calorimeter or "heat gauge" portion of the calorimeter as it is called by Mr. Barrus, will be practically dry when there is as high as 60 lbs. of moisture drawn from the separator per hour.‡ This is for a throttling orifice $\frac{1}{8}$ inch in diameter which is the size we have adopted in all our tests.

This gives a ready means of determining the normal reading of the thermometer used in the calorimeters *B* and *C* which can be placed in the calorimeter *A* in turn and a record taken for, say, one hour before replacing them in *B* and *C*.

The calorimeters are run continuously and are all of the same form and covered with felting or other material in the same way to diminish their radiation so that by obtaining the normal reading in this way we correct for all radiation as well as any error in the thermometers. This is a great advantage as one can readily appreciate who has endeavored to employ the theoretical formula in which the normal reading need not be determined by experiment but where the amount of radiation of the calorimeter and of the piping leading to the same must be determined separately, together with the connections to reduce the readings of the mercury thermometer to those of an air thermometer.

The pipe leading from the separator *G* to the calorimeter *A*,

---

* Relative results may be obtained closer than one-fifth of one per cent. and with special care the normal reading determined by experiment may be identified as the minimum or maximum normal reading. In our work presented to the American Society of Mechanical Engineers, the results were shown to agree with those that would be obtained if the minimum normal readnig was used or that corresponding to quiescent steam which is condensing.

Experiments are needed to show which state of steam comes the nearer to the steam of Regnault's experiments but until this is done we cannot work closer than one-fifth of one per cent. with the throttling calorimeter.

† Transactions A. S. M. E., Vol. XI, p. 790.

‡ Transactions A. S. M. E., Vol. XVI., page 1029.

is of the same length as that leading to the calorimeters B and C. The normal readings obtained by placing the thermometers in A are therefore affected by radiation to the same extent as the readings of the thermometers in B and C and as the difference of the readings is employed in the calculations, the radiation will not affect the result.

The method of calculating the percentage of priming in the steam passing through the calorimeters B and C is as follows:

If N is the normal reading, Deg. Fahr., obtained by placing the thermometer in A;

T, the reading when placed in either B or C;

L, the latent heat at the pressure of the steam in the steam main in $B. T. U.$ per pound:

Then the percentage of priming for the steam passing through the calorimeter is $\frac{48}{L}(N-T)$.

PRINCIPLE OF THE GAS COMPOSIMETER.

BY EDWARD A. UEHLING, M. E., '77.

The Gas Composimeter is based on the laws governing the flow of gas through small apertures.

If two apertures such as A and B (Fig. 1) form respectively the inlet and outlet openings of a chamber C, and a uniform suction is maintained in the aspirator D, the action will be as follows:

Gas will be drawn through the aperture B, into the chamber C′, creating a suction in the chamber C, which in turn causes the gas to flow through the aperture A. The velocity with which the gas enters through A depends on the suction in the chamber C, and the velocity at which it flows out through B depends upon the excess of the suction in chamber C′, over that existing in C, that is, the effective suction in C′. As the suction in chamber C increases, the effective suction must decrease, and hence the velocity of the gas entering A increases, while the velocity of the gas passing out through B decreases, until the same quantity of gas enters at A as passes out at B. As soon as this occurs, no further change of suction takes place in the chamber C, providing the gas entering at A and passing out at B are kept at the same temperature.

If from the constant stream of gas while flowing through chamber C one of its constituents is continuously removed by absorption, a reduction of volume will take place in chamber C and cause an increase in suction and consequently a decrease in the effective suction in C′. Hence the velocity through B will decrease until the quantity of gas entering at A, is greater than that which passes out at aperture B by the quantity absorbed by the reagent.

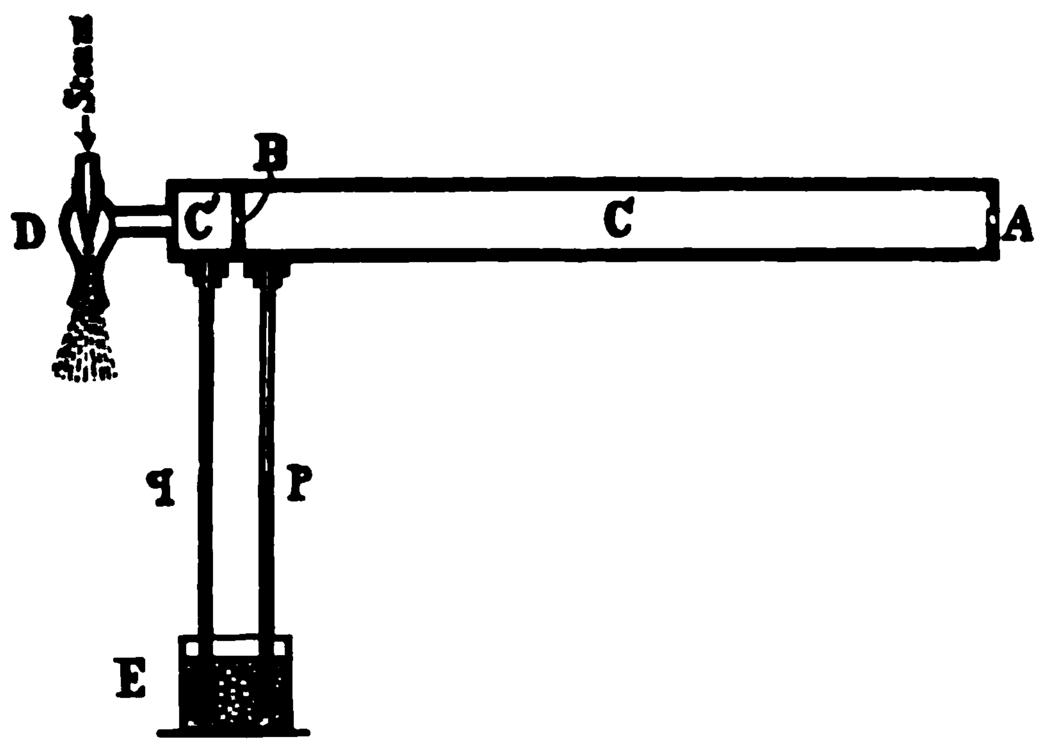


FIG. I.

Thus every change in the volume of the constituents we are absorbing from the gas causes a corresponding change of suction in the chamber C.

If two manometer tubes p and q, (Fig. 1) communicate respectively with the chamber C and C', the column in the tube q indicates the constant suction in C', and the column in the tube p indicates the suction in C, which suction is a true measure of the percentage of the constituent we wish to determine in the gas.

PRACTICAL APPLICATION OF THE PRINCIPLE OF THE GAS COMPOSIMETER.

To embody the principles described into a practical apparatus, the following conditions must be fulfilled :

(a) The gas must be brought to the instrument under a constant tension and must be drawn through the apertures with a continuous and perfectly uniform suction.

(b) Both apertures must be located in a medium of constant temperature.

(c) Provisions must be made that the apertures remain perfectly clean.

(d) The chamber C must be perfectly tight so that no gas can enter except through the aperture A.

(e) Provision must be made to render the gas free from moisture.

(f) The constituent to be measured must be completely absorbed after the gas passes through A and before it passes out at B.

Figure 2 is a diagramatic view of the apparatus meeting all the conditions for practical operation.

The suction is produced by a simple steam aspirator E and is controlled by the regulator H.

CONDITION A.

This regulator for a single instrument consists of a cylinder 8 inches in diameter and 5 feet high, into which tubes *a*, *b* and *c* project from the top downward. The tube *a* is open to the atmosphere and extends to within 2 inches of the bottom. The end of tube *b* is exactly 48 inches above the lower end of *a a'* and the lower end of *c c'* is just 6 inches above the lower end of *a a'*. The cylinder is filled with water so that the tube *b* is submerged several inches. If the aspirator E is started a suction is created in the air chamber C″ above the water, which suction increases until the pressure of the atmosphere overcomes the pressure of the column of water in the tube *a'* and the air bubbles up through the water into C″ satisfying the aspirator and preventing any further increase in suction.

D and D′ are filters, *d* is the outlet for the gas and *d'* is open to the atmosphere. These filters communicate respectively with the pipes *c* and *b* by the apertures *e* and *e'*; so long as the suction is sufficient to draw air through *a a'* the horizontal plane of water *v v'* in which the pipe *a a'* terminates is under atmospheric pressure. The plane *y y'* lying 48 inches higher, is under a suction of 48 inches of water and the plane *z z'* is under a suction of 6 inches of water. The aperture *e* is so gauged that more gas will pass through it than is required for analysis, the

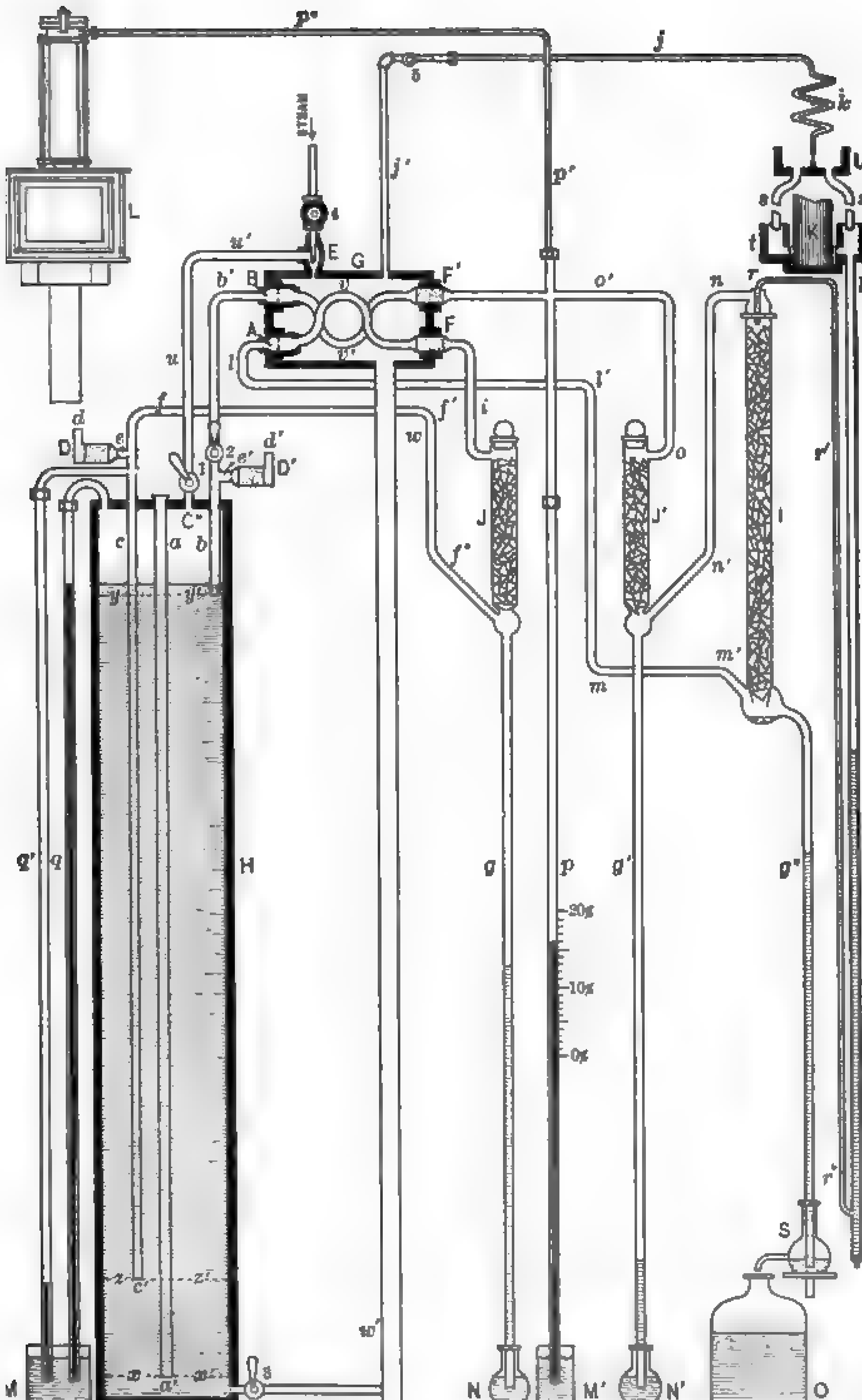


FIG. 2.

excess escaping at c' and bubbling up through the water into C' from where it is drawn off by the aspirator together with the air entering through a a' and b'.

The tube b b' represents the chamber C' of Figure 1 and by virtue of its relation to a a' it is under a constant suction of 48 inches, similarly tube f, c, c', from which the gas flows to aperture A is under a constant suction of 6 inches of water. This arrangement therefore fulfills condition A perfectly so long as the water level in H is not allowed to fall below the plane y y'; when this occurs the water must be replenished.

CONDITION B.

Condition B is fulfilled by placing both apertures A and B in the chamber G, which is kept uniformly at a temperature of 212 degrees by the exhaust steam from the aspirator which is permitted to escape at atmospheric pressure.

CONDITION C.

A large filter at the source of gas supply together with the small cotton filters D, F and F' protect the small apertures perfectly and fulfills condition C.

CONDITION D.

Chamber C is composed of all the tube connections and chambers between the apertures A and B. All the metallic tubes are of drawn copper tubing, all flexible connections are of especially made rubber tubing and all joints are very accurately made and carefully tested so that condition D is perfectly met.

CONDITION E.

The gas from the chimney or other source is first passed over a water cooled surface and through a large cotton filter (not shown) which condenses the bulk of the moisture, and cleanses the gas. The drying tubes J and J' absorb the remaining traces of water. These drying tubes are filled with small lumps of calcium chloride. The lower ends terminate in

tubes g and g' which are sealed at the bottom by dipping under water in the bottles N and N′ respectively. The moisture absorbed gradually dissolves the chloride of calcium and the solution trickles down into the bottles N and N′. As necessity requires the drying tubes are replenished and the bottles emptied. This provision dries the gas perfectly and fulfills condition E.

CONDITION F.

To eliminate a constituent from a continuous stream of gas with certainty, a continuous supply of an efficient absorbent flowing in the opposite direction and exposing abundant surface must be supplied. By means described below the absorbing solution is caused to fall, drop by drop, from the small pipe r into the absorption tube I which is filled with glass beads or other substance that presents a large surface to the reagent trickling down through the tube and to the gas flowing up. By proper regulation of the strength and quantity of the flow of the absorbing solution condition F is perfectly satisfied and the desired element completely absorbed. For the absorption of carbon dioxide commercial potash cast in sticks about two inches in diameter and of convenient length is employed. The central chamber contains potash K. Above the vessel U is another vessel U′ which is provided with a knife edged partition and branch pipes s s' on either side of the partition terminating respectively in the chambers t and t' of vessel U′. Directly above the knife edged partition is the outlet end of a condensing coil k, which receives steam through the pipe j j' from the equal temperature chamber G. The vessel U communicates with the absorption tube I through the tubes h h' and r'' r' r, the former is closed at the bottom by a cork and the absorption tube is provided with a branch tube g'' which terminates in the bottle S where it is closed to the atmosphere by a liquid seal. S is provided with an overflow into the jar O.

Three manometers are provided dipping into the water in the vessels M and M'. Of these *q* communicates with the chamber C'' and indicates the total suction and incidentally also the water level in the regulator H: *q'* is connected with *c c'* and shows that the gas is supplied to the instrument under constant suction. Manometer *p* communicates with the pipe system representing chamber C (Fig. 1) and with the proper scale attached will always indicate the percentage of the constituent of the gas absorbed. By the pipe *p' p''* chamber C also communicates with the recording gauge L. The equal temperature chamber G is provided with an ample waste pipe *w w'* into which the water of the regulator H can also be drained by the opening cock 3.

The inlet *d* of filter D having been connected to the source of gas the operation of the Gas Composimeter is as follows:

If valve 4 is opened, the aspirator E at once creates a suction in the chamber C'' which increases until the atmospheric air enters through the pipe *a a'*, bubbles up through the water in H and is drawn off by the aspirator E through the pipe *u u'*. Adjusting cock 1 so that the air bubbling up through the water is reduced to a moderate amount the other suctions are at once automatically regulated as already described.

The constant suction of 6 inches of the water column in *c c f* brings the gas to the instrument. In passing through the filter D it is cleansed of any solid matter that may have passed through the large filter. The gas in excess of the amount required for analysis escapes at *c'* through the water into C'' and is drawn out by the aspirator. With cock 2 full open the superior suction of 43 inches in pipe *b b'*, draws the gas required by the instrument through the pipe *f f' f''* into the drying tube J, whence after being deprived of its moisture it flows through *i* and the filter F into the coil *z* which being located in chamber G which is constantly kept at 212 degrees by the exhaust steam from the aspirator. The gas is there heated and passes through the aper-

ture A at 212 degrees, thence through *l l'* and *m m'* into the absorption tube I, where it meets the solution of caustic potash, trickling down through the filling of the tube.

Here the constituent, carbon dioxide, is immediately absorbed, the remaining gas passes through *n n* into the drying tube J where any moisture that may have been taken up from the potash solution is taken out. Thence the gas flows through *o o* and filter F' into the coil *r'* where it is again heated to 212 degrees at which temperature it passes through aperture B and by the pipe *b b* into C' from where it is drawn out through *u u'* by the aspirator E. The exhaust steam from the aspirator keeps the chamber G constantly at 212 degrees. Part of this steam passes by the pipe *j j* into the coil *k* where it is condensed. The drops of condensed water falling on the knife edge partition in C'' can be so divided that equal parts shall reach the chambers *t* and *t'* or that more shall enter *t* than *t'* or vice versa. That portion of the water which falls into chamber *t* must flow past the stick potash K and becomes a saturated solution while, that which drips into the chamber *t'* serves to dilute this solution to the proper degree. By adjusting the terminal of the coil *k* over the knife edge the strength of the solution can be readily regulated. The solution flows down the pipe *h h'* at the bottom of which any dirt may settle and can be occasionally drawn off. By the small pipe *r'' r' r* the clear solution is siphoned over into the absorption tube. The above arrangement permits of very accurate regulation both as to the number of drops per minute and to the strength of the solution required and insures continuous and regular flow of the absorbing agent in the opposite direction to the current of gas.

Manometer *q* indicates the suction in C'' which must never fall below 48 inches. Manometer *q'* indicates the tension under which the instrument receives the gas and must always stand at 6 inches and will not vary unless there is some obstruction in the

Fig. 5

gas supply pipe or filter. p continuously indicates and the recording gauge records the percentage of the required constituent in the gas as it flows through the instrument.

Figure 3 shows the single instrument as exhibited at the 25th anniversary of the Institute. The regulator is provided with a wide flange at the bottom to give it stability; the equal temperature pot is arranged directly above the regulator. The drying and absorbing tubes are located in a closet to the left, and the recording gauge sets on the bracket to the right of the main instrument. These parts are preferably located together, but

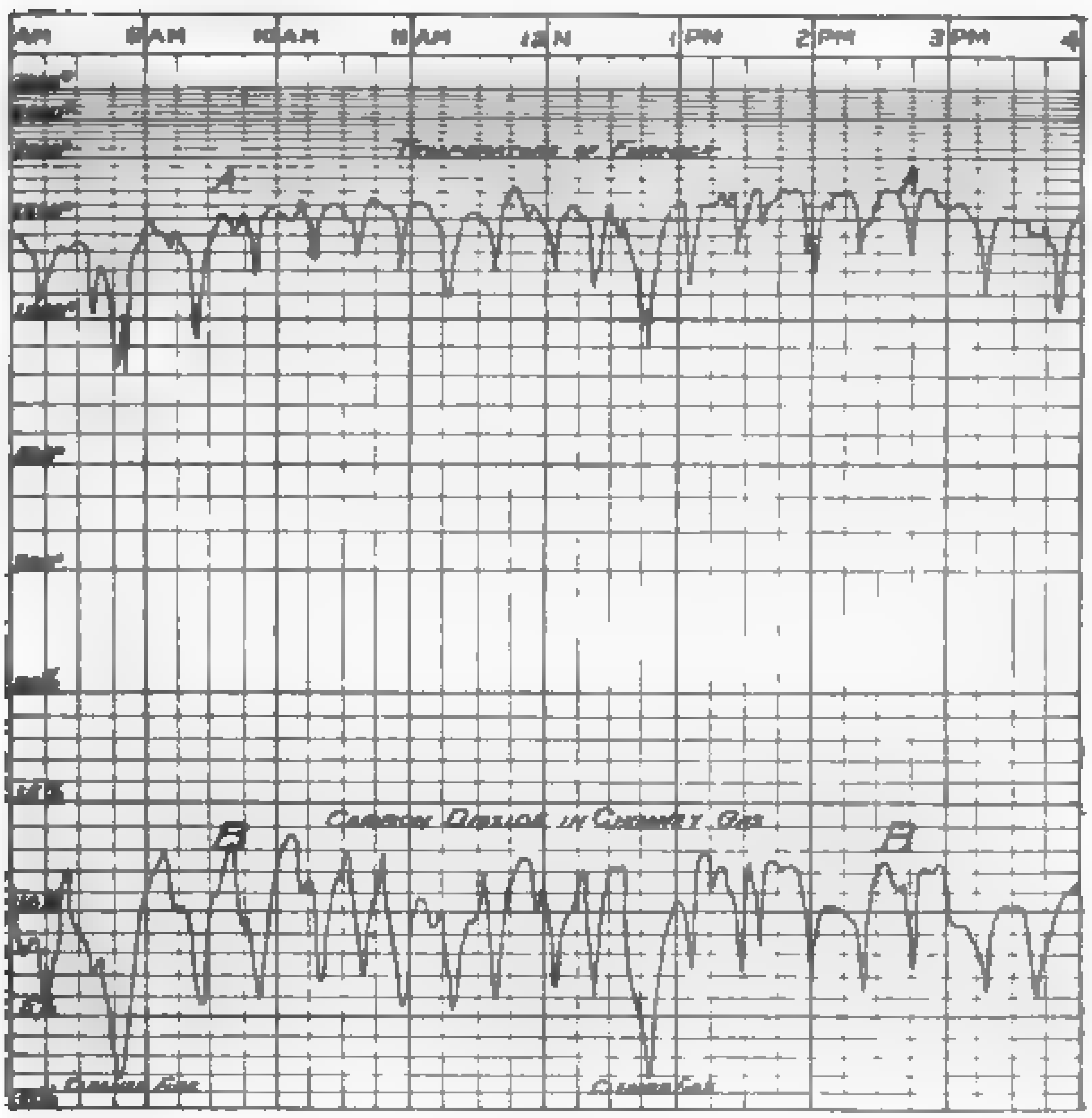


FIG. 4.

[illegible] be placed [illegible] feet away from the chimney [illegible]. When a number of instruments are [illegible] the recording [illegible] can be [illegible] the [illegible].

The accompanying diagrams are autographic records taken by the Gas Composimeter and Pyrometer [illegible] the [illegible] of [illegible].

[illegible] Fig. [illegible] is a fac-simile of the record of CO_2 in the chimney gas taken by the Composimeter. [illegible] is a parallel record of the temperature above the grate simultaneously taken by the Bristol Recording Thermo-Gauge attached to the [illegible] Pyrometer. The depressions indicate the time of opening the furnace door for the purpose of firing. The smaller depressions indicate the automatic closing of the chimney damper. The remarkable coincidence of the two records in the variations produced by a cause which must necessarily affect both the CO_2 and the temperature record in the same direction, viz., the influx of cold air in firing, forcibly illustrates the sensitiveness and the accuracy of these instruments.

The practical value of the Gas Composimeter we shall attempt to bring out in a succeeding article.

COURSE OF LECTURES ON BUSINESS METHODS.

A full announcement of the course of lectures delivered before the Senior class last Spring, was made in the July number of the INDICATOR in which was also published the lectures of Mr. H. de B. Parsons, M. E., '84 and Mr. William Sherrer, manager of the New York Clearing House. The course comprised four lectures and the remaining two are now given.

IS A KNOWLEDGE OF BUSINESS METHODS OF IMPORTANCE TO THE ENGINEER?

BY ALEXANDER C. HUMPHREYS, M. E.

With many of us who are engineers and with some of us who are graduates of Stevens this question hardly admits of discussion. Our professional and business lives have demonstrated to us practically and completely that the engineer who aims to be more than a mere subordinate should be at least acquainted with the methods ordinarily pursued in business life and that even to the subordinate, such a knowledge is of importance.

But on the other hand there are many who will tell you that the engineer is above the necessity for such an addition to his curriculum; that he can, if necessary, hire his book-keeper and his business manager for a moderate compensation and much to the same effect.

My experience goes to show that the men who thus argue are very apt to wind up by being hired at a moderate salary by the business manager.

A number of us who are Alumni of Stevens have for some time felt that it might be of considerable importance to the students, yet to start out in life, if they could by some means be impressed with the importance of a knowledge of business methods.

Mr. H. de B. Parsons, Stevens '84, the late president of the Alumni Association, made this idea a prominent feature of his

presidential address last year, and to him we are largely indebted for bringing the present plan to a trial.

We have all appreciated that the Stevens Course is a most severe one and that it should not be inadvisedly added to, but we have thought that something could be done by means of a short course of lectures which, if appreciated by the students, would be of real value to them.

President Morton has from the time of the first suggestion encouraged the making of the trial, and I doubt not that his own experience as a successful man of affairs has argued with him in favor of the new departure.

It cannot be expected that through the medium of a few lectures you can become competent bankers, merchants or even accountants, but it may be expected that even these will be sufficient to impress upon some of you at least that a knowledge of business methods is of importance to the engineer and also to teach you the underlying principles involved. If, with your coöperation, we can accomplish this much, we shall feel well satisfied.

My experience as an employer of technical men, most of them graduates of Stevens, has taught me that many, even of the more sensible ones, the ones best endowed with common or "horse" sense, have at first failed to appreciate that there was anything in connection with business methods which demanded their respect. This has been the weakness with a number of otherwise strong men. It has been their inability or reluctance to learn in this direction, which has a number of times necessarily prevented them from obtaining promotions which otherwise they had earned. I could, if I thought it desirable, give a number of cases which would drive home this part of my argument.

A friend of mine was recently talking to me on this subject. He is a capitalist and a large employer of labor of various grades. He spoke of Stevens graduates as being in his experience excellent men *after they had been out of college about three years*; that it took about that long for them to get over the feeling that they occupied a lofty plane as compared with the business man, and to appreciate that it was necessary they should learn something from the business man if they wished to fill positions of responsibility.

Another, and an intimate friend, who is one of the best balanced men that I know, a practical engineer, a remarkably strong man in business and financial affairs, a man who though self-educated is well educated, and who has a profound respect for a technical education, says that he is continually disappointed that he cannot promote his technical men as rapidly as he desires, and the reason is that they are lacking as business managers.

Another friend, a graduate of Troy Polytechnic, and now occupying a position of great responsibility, having worked up from the practical side of his business, told me recently that there was no part of his course which, in looking back through his experiences, he felt had been so distinctly of benefit to him as some extra lectures on contracts and the law of contracts which he had listened to at the end of his course. I may not be prepared to go so far, but it may serve a purpose to show how strongly some successful practical engineers feel on this subject. This friend was very emphatic in the expression of the opinion that the technically educated men who had been the most successful under him, had been those who were able to see quickly that there was something beside the technical side of an education, and that it was also necessary to be practical, systematic, business-like, familiar with the requirements of business life and conventions.

Probably the most important engineering society in the world is the British Institution of Civil Engineers. In its diploma or certificate of membership appears the following:—

"A society established for the general advancement of Mechanical Science and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in nature for the use and convenience of man."

This statement shows clearly that ours is an eminently practical profession. We may be interested in science for science's sake, but that is not so in our capacity as engineers. In that capacity, we are, as a rule, simply called upon to apply the laws as already determined and laid down for us. We are to direct the great sources of power in nature for the use and convenience of man. A moment's thought shows how complete, for success, must be that harmony between theory and practice, as so beauti-

fully set out by Rankine in the preface to his applied mechanics; and this harmony of theory and practice must include harmony with the practice of the business world.

How are the great sources of power in nature to be directed, except by the employment of capital? and how is capital to be employed in connection with engineering work except in conformity with the regular methods employed in commercial life? Shall we alone refuse to accord respect to these methods and declare that commercial practice shall bend to our whims? Even then, some other methods must be substituted, and can we for a moment assume that the methods we should substitute would be generally preferable to those developed by specialists in that line?

To me it seems absurd that any argument should be needed to enforce this simple point, but as I have said, experience has only too fully shown the necessity for awakening technical men to their general weakness in this direction.

If I cannot by my arguments convince you that it is important to keep an open mind in this connection, then let me ask you to take it from me on faith. One or two have done this in the past, and they have been glad to come to me in later years and acknowledge that the faith was not misplaced.

I believe every man should have some knowledge of business methods, if only for his own protection, but I acknowledge, in the case of certain specialists, this necessity does not seem to be marked, as for instance, with ministers, chemists, physicians, dentists, etc., but you must remember you are not a specialist in this same sense. As I have said, our profession is eminently a practical one and cannot be isolated from its commercial associations.

If I am right and a knowledge of business methods tends to make your educational equipment more complete and more practical, you cannot, in this age of tremendous competition afford to neglect it. Bear in mind that the conditions surrounding capital and labor have greatly changed in the last twenty years, yes, in the last five years. Year by year it is getting harder to secure a fair return upon money invested. In the United States, many successes in the past have been secured only because the condi-

tions permitted wasteful methods. These successes under conditions more nearly normal might well have been dire failures. Think for a moment of the effect of building up in this country about 183,000 miles of railroad in about half a century. That means, in a certain sense, a fictitious activity in many departments of industry, brought about by the spending of large sums of capital, chiefly foreign, brought out for investment. And now we have to pay the interest on this capital, and to help us in this, we are never again to have such a vast amount of work of development bringing in its train what is popularly known as "good times." This means that it will be harder to secure employment and harder to secure adequate compensation therefor. It also means that more and more must capital be husbanded. This all means, then, that in our work as engineers, the cents must be watched and accounted for. How is this to be surely done unless we are familiar with the methods employed in the financial world, and especially familiar with the methods of accounting.

The engineer of to-day must be able to obtain not only good results in construction and in operation, but he must be able to so record those results that they can be completely analyzed and compared. It is to be noted that the man who does so record and analyze his results is seldom an extravagant constructor or operator.

Making some such argument as this to a friend of mine, a Stevens graduate and a successful man, he replied to the effect that there was no necessity for his bothering his head about such matters, as he could hire a book-keeper for ten dollars a week to do such work for him. The kind of book-keeping you can secure at ten dollars a week is not the kind I am talking about. I do not urge upon you the necessity of facility in posting a ledger and in footing up long and wide columns of figures, but I am urging the necessity of an understanding of the underlying principles of accounting.

You do not go to Stevens Institute to become a mechanic, and still the course includes shop work. You aim by the combination of practical and theoretical training to become competent to intelligently direct mechanics, who may perhaps be able to do a better piece of mechanical work and do it more

quickly than you can. By such powers of direction you expect to be more valuable to your employer than the mechanic, even though the mechanic can earn at the bench better wages than you can.

This all applies to the case of the book-keeper.

Because you may fail to compete with the mechanic in facility of execution is no reason the shop course of Stevens should be abandoned, and because you do not want to spare the time and effort to acquire great facility in the keeping of books, does not argue that you should not acquire a knowledge of the principles involved.

I have always felt that the responsibility of the engineer in this respect is greatly increased by reason of his mathematical training. With this training, he should have no difficulty in easily mastering the principles of double entry book-keeping, for the system is logical and consistent. A man who has gone through the higher mathematics should be ashamed to confess that there are any terrors for him in double entry book-keeping. The trouble is, of course, that at the beginning the engineer often fails to appreciate the value of this knowledge, and then later he is fully employed or lazy, and not knowing how to go to work, he pushes the matter to one side.

Let us suppose for an instant that you are called upon to examine into the value of a manufacturing property. Say that in connection with the examination there are presented to you, a ledger trial balance, a profit and loss statement and a statement of assets and liabilities. It goes without saying that you should be able to understand these statements. Can you be sure of doing so without a knowledge of accounting by the double entry system? I speak of this system especially because it is the one almost universally employed in important business undertakings and it is the only system which can be safely employed by reason of the fact that if an error creeps in, no balance can be obtained and so the error is detected, which is not the case with the single entry system.

Returning to the question of the examination, you may reply that you can employ an accountant to make this part of the examination. Very true, you may do so in any case, but it

would still be necessary that you should understand the principles involved in the accounting, or it would be necessary that your accountant should understand much of the technical and practical part of the business, for without such a knowledge he could not surely tell whether or not the accounts were properly classified, and unless they were so, the statements furnished would be valueless. I have repeatedly had experiences of this kind. I have many times found the books of a concern so kept by the book-keeper, the practical head of the concern being either ignorant or indifferent in this direction, that the profits were more or less erroneously stated, and this because items were carried into construction accounts which should have been carried into operating accounts.

I could cite a number of most striking cases of this kind ; in some of them it would have been difficult, to say the least, for an accountant to have discovered the errors unless he was specially trained in the particular business under examination. I have been engaged in some such cases where it has taken days, weeks, yes, even months to get the accounts so straightened out that a completely accurate statement of results could be obtained.

Now it is to prevent just such a state of affairs as this and to enable you to detect it when it exists, that you should understand accounting.

Do not fail at once to recognize the importance of carefully classifying all receipts and expenditures.

It is the balancing of the operating accounts which at the end of the year determines whether you have made a profit or a loss by the year's operations.

If now, you have improperly charged certain expenditures to construction or investment accounts, you have falsely increased the statement of your profits. If you draw this fictitious profit, you are really drawing upon your capital ; if this is continued, it is not hard to say what must be the end. It is then of the utmost importance that the accounts should be intelligently and honestly classified.

This sounds simple enough. Let me assure you that in some cases it is extremely difficult to secure the desired result.

Let me give you a leaf from my own experience. I had

under my charge about forty gas works, and it was of course most desirable that the results should be compared carefully in the interest of economy; we finally secured a very complete system of united management. The same general business methods were employed at all the stations, the same system of classification was employed and this was carefully displayed for the instruction of all by means of detailed charts and instructions. The vouchers were carefully checked up, month by month, at the main office. Systematic audits were periodically made by a trained corps of auditors. The superintendents and managers met me once a year to discuss results and the records of the same. And still in spite of all this, we found that if the comparisons were to be really fair and intelligent they often had to be made while carefully bearing in mind all modifying conditions. Think then, how difficult it may be to make comparisons between results obtained by concerns not working under a united and uniform system of management. Especially is it hard at times to distinguish fairly between charges to repairs and to extensions or improvements. Often the work is designed to replace construction which has been worn out in service. Here then care has to be exercised that the operating accounts are charged with their full share of the renewal and that the betterment or investment account is not called upon to bear more than its share of the load, thus impairing capital.

Those familiar with business methods will tell you that in this lies the pitfall which has ruined many a good business. In this direction, may we look for the fault which has led to the reorganization of so many American Railroads; over-capitalization in the first place, and later, repairs and renewals charged to construction accounts.

Some will say that it needs no special business methods or knowledge of accounting to know all I have now said; it only requires common sense. Very true, if the common sense is sufficiently developed. It will do no harm to point out, in any case, that your common sense has to be exercised in this direction, and then if you think that your common sense is not sufficiently developed you may be correspondingly the more on the alert.

As a rule, as I have before indicated, my experience goes to

show that technical graduates find their common sense lying so dormant in this direction, that they refuse to believe there is anything here which demands their attention or their respect.

The proper charging up of the ordinary cash repairs and simple renewals, offers no difficulty. The cash as paid out will be charged to its proper repair account and it will be found at the end of the year in its proper place in the statement of profit and loss. But there are more complicated items. I have already referred to one, where the repair item is combined with one of improvement. You cannot be too careful in avoiding trouble here.

But there are repairs, or rather renewals, which have to be made at longer intervals, and the cost of which cannot fairly be placed upon one year's business. Means should be taken to determine the life of this part of the plant, and year by year a sufficient sum should be written up to a deferred repair or renewal account, so that when this part of the plant does have to be renewed, the funds will be ready for the expenditures and they will not have been paid out in dividends, owing to misleading statements of profit and loss.

This points to the necessity of providing in your system of accounts for the renewal of the entire plant at the expiration of the terms of life of its several members.

But you may say, surely an engineer may be able to design a good engine, or bridge, or roof, without a knowledge of all these matters. Possibly so in a subordinate capacity. But if this engine, or bridge, or roof is to be sold in competition, as it must be sooner or later, then the designer must also keep in mind that there must be a minimum of cost combined with a maximum of efficiency. This means that every part of the work must be followed through the shop from tool to tool, and the whole carefully classified for future analysis and comparison.

And this brings us to another most important branch of our subject:—

Shop accounts and their proper classification.

Before we can fix a price on an article to be sold, we should know its cost. But this is hard to determine unless our shop accounts are accurately kept. I venture the assertion that in

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

afterwards be able to tell these gentlemen that their unselfish efforts in our behalf have been appreciated.

In conclusion, let me repeat, that in my opinion, an engineer, to be truly successful, must be more than a narrow specialist. He must have the special training, but he must also have the broader and more general training which comes from contact with the world and with things commercial.

Especially remember that the engineer is a man of practice. It is for him to apply knowledge. In his profession it is better that he should have a limited, if thorough special training and a large capacity for the application of that training combined with breadth outside of this special line, than that he should have a great store of knowledge without the ability to practically apply it. Do not imagine that I am depreciating profound and wide engineering knowledge. Lucky the man who combines such stores of knowledge with the ability to use it for the benefit of the world and of himself.

But if I cannot have that combination, I prefer the limited amount of knowledge combined with the ability to apply it efficiently. Such a man can do thorough, conscientious, good work, and if he carries on his work in conformity with correct business methods, he can, while doing some good for the world in general, do also some good for himself in particular.

ACCOUNTS AND ACCOUNTING.

BY MR. GEORGE R. TURNBULL.

In my endeavor to supplement the able address on "The Importance of a Knowledge of Business Principles," given by your Trustee, Mr. Humphreys, I will, as far as the brief limits of time permit, present to your attention the importance of accounts and accounting as one of the leading features of a business education.

In primitive times, when "swopping" or bartering was the only method of trading, the necessity for accounts was not felt,

and bookkeepers were not in demand. But when trading became further advanced, when barter through the medium of traders took the place of barter direct, when things were represented by money-prices and values, it then became necessary to keep some kind of a record of the transactions and the amounts involved. And here I would suggest a thought for your consideration, and it is—that barter is as absolute to-day through the medium of a merchant and by the use of money as when commodities were passed from hand to hand, and following out this idea practically and logically, you will arrive at the conclusion that money does not make prices, for the reason that no one will continue to produce crops or wares which do not finally give a satisfactory return in the things he is accustomed to receive in exchange, or, to put it in the language of the day, we cease to follow any business or vocation that "does not pay."

When our transactions are few and far between, we may trust to memory. I have known men who carried their business in their heads, but it is a great waste of effort and brain to place such a tax on memory, and memory, however good, cannot be relied upon to recall all the facts, dates and figures involved in numerous transactions, hence recourse to a record of some kind becomes a necessity.

Any one can put down a statement of the bare facts involved in a transaction that will serve to refresh the memory in regard to it, but when the transactions are of any importance, it becomes absolutely necessary to go further, and the record must show, not only our original possessions and the disposition made of them, but our exact relations at any given time to those with whom we trade and have dealings, especially where credit is involved. This suggests the need of some systematic method for arriving at these results, and what is known as Single Entry Bookkeeping is the first outcome. The first step in this system is to enter simple statements such as the following :

That we have bought certain things from a certain person at a certain price, to be paid for at a certain time ; or

That we have sold and delivered certain of our goods or property for a certain price, payable at a certain time ; or

That we have received cash payment for goods delivered ; or

That we have paid a certain party for goods received ; or

That we have received the written promise to pay of a debtor in settlement of an amount due us (which promises are in Bookkeeping known as Bills or Notes Receivable) ; or

That we have delivered our own promise to pay for value received (known as Bills Payable); or

In the event of an exchange, as often happens in real estate transactions, a record of the exchange made, with a description of the properties ; or

That we have paid not for goods but for services, for rents, for interest, or expenses of any kind ; or

That we have received payment for services, rents, etc.

These are all natural entries suggested by the facts in the case, and these entries (known as original entries) are the groundwork of all systems of book-keeping and are of the utmost importance, because they are the only entries recognized as evidence in proceedings at law. And, in this connection, I want to emphasize the importance of making original entries so complete that ever after the transaction may be as readily understood from the entry as when it was actually made. Nine-tenths of the trouble with book-keepers arises from the incomplete and careless manner in which first or original entries are made. Brevity may be the soul of wit, but it is frequently the confusion of accounts.

These entries, with the exception of matters pertaining to cash, are usually entered in what is called the Day-Book. Cash items are usually entered in a book known as the Cash-Book, which is simply a subdivision of the Day-Book used because of the more convenient determination of funds on hand.

In both Single and Double-Entry Book-keeping, the ledger accounts are headed with the names of the parties with whom transactions are had, and also such impersonal accounts as Merchandise, Cash, Bills Receivable, Bills Payable, Expense and subdivisions thereof, and others according to the character of the business, and from the Day-Book and Cash-Book are transcribed into the ledger the amounts involved in the various transactions. This is called "posting."

Now, it must be very apparent to you, that the omission of an entry, or the failure to transcribe an entry into the ledger,

opens the door to loss and error. This cannot happen without discovery in cash transactions, because the cash is usually footed and proved, and the balance, if it does not prove, evidences the failure to make an entry, an error in making one, or a mistake in handling the money. This method (Single Entry) is the one that commonly obtains among retailers and petty tradesmen, and though it is called "Single Entry," I am sorry to say that an examination of tradesmen's bills sometimes leads to a belief that they possess some latent knowledge of double entry.

Because of the grave probability of error and great possibility of fraud, Single Entry book-keeping, even in its best form, is unsatisfactory, and is not used, except in rare instances, outside of retail business. The only system worthy of consideration is that known as Double-Entry Book-keeping, sometimes called the "Italian Method," because of its Italian origin. Double-Entry Book-keeping may be defined as the most accurate method or system of recording business transactions,—its very nature requires the record of *all*, not part, of our transactions.

I want to say, in preface to my description of Double-Entry Book-keeping, that we have in every trade, barter or transaction, by whatever name you designate your dealings, an exchange. This exchange involves a person, firm or corporation with whom the exchange is made. Keep this thought clearly in your minds, for from this springs one of the fundamental rules of book-keeping, but before giving it I want to state the first rule, which is, that for every debit there must be a like or equal credit,—equal, that is, you may have any number of debits to persons, say for goods, the aggregate appearing in one amount at credit of Merchandise Account; or any number of credits and only one debit, the debit being the sum of the credits. This leads me also to call your attention to the word "balance," so frequently used in connection with accounts. You are aware that the word balance is synonymous with scales, and the old-fashioned scale with its two pans furnishes a very simple illustration of this prime rule of double-entry book-keeping. Suppose a pair of scales before us, —if we put as much in the one pan as in the other, the scales would stand even, or balance. This is equally true in book-keeping by double entry. For, if we debit one account with

$1000, and credit another with $1000, the amount at debit and the amount at credit, being equal, balance, and the statement of that fact would be what is known as a "Trial Balance Sheet," which is a statement of all the balances on the ledger, and on which, if correct, the total of the debit balances agrees with the total of the credit balances. This is the rule which gives rise to the name "Double-Entry."

A very important feature in connection with Double-Entry Book-keeping is, that property, goods and possessions are treated as debtors—the accounts are known as impersonal accounts, taking their titles from their character, such as Cash Account, Merchandise Account, Bills Receivable, Real Estate Account, Bond Account, or, in a manufacturing business, in addition, such as Machinery Account, Tool Account, Fixture Account, etc.

We will illustrate the matter by supposing that you are going to start in business. People commence business with money. Sometimes, however, only with credit, a very valuable possession, because it is given, as a rule, only to those who possess ability, industry and integrity,—three winners in the race for success.

To open your books, you would start your Cash Account and on the left hand side of the page enter, "Cash, Dr. to —— (yourself)" for the amount of money in your possession. The left hand page in cash and the left hand columns of ledger and journal are always the debit, and the right hand side the credit. Now here we have the account of the thing (Cash) debited and the account of the person (yourself) credited. This illustrates also, the only other rule involved in Doubly-Entry Book-keeping, and that is when you part with a thing,—merchandise, cash, real-estate, or anything of value which is represented in your business, you credit the account of that thing and debit the account of the person to whom you give it. On the contrary, if you receive anything, you debit the account of the thing received and credit the party from whom you receive it. In other words, your possessions owe you,—as well as individuals. To recapitulate: We have two rules which govern all original entries in Double-Entry Book-keeping:

1st. For every debit there must be an equal credit.

2d. Debit the account of the thing received and credit the

account of the party from whom you receive it; or, transposed, credit the account of the thing given and debit the account of the party to whom you give it.

We now have in our minds the rules governing our entries and the importance of making our entries so clear and complete that they never require any explanation. Let us now consider the books themselves in which the entries are to be made. Originally, and down to quite recent years, a set of books consisted of a Day-book, Cash-book, Journal and Ledger. In the Day-book were made all original entries of purchases, sales, exchanges, settlements—everything except cash matters. It was formerly the rule (which is still occasionally practiced) to reenter in the Journal, in the technical form, all entries from Day-book and Cash-book, as—

Apl. 5. Jones and Co., Dr. to Mdse.

For goods sold them on 4 mos. credit, as per Day-book folio 11 . . . . $1,000

or

Mdse. to Smith & Co.

As per their invoice of Apl. 5, for 10 cases of sheeting bo't on 4 mos. credit, per Day-book folio 11 . . . . $500

or

Sundries Dr. to Cash.

Comprising each of the parties to whom cash was paid, the purpose of payment, etc., etc.

From the Journal the entries are posted into the Ledger under their respective accounts. As in the cases cited, Merchandise Account would be credited under the date of

Apl. 5. By Jones & Co., Jl. 1 . . . . $1,000

and Jones & Co. would be debited under the date of

Apl. 5. To Mdse., Jl. 1 . . . . $1,000

The Journal has two columns: one, the left, for debits, and the other, the right, for credits. These are footed and carried forward to the end of the month (usually) and the agreement of totals shows that the debits and credits are equal, and as to amount, correct.

With a view to the economy of labor, the journalizing of sales, purchases and cash is now dispensed with, and instead, the sales are entered in a Sales-book, purchases in an Invoice-book and postings are made direct from these and the Cash-book into the Ledger. Of course you will understand, that in various lines of business similar books may be introduced adapted to the particular business in view,—my purpose is simply to call your attention to the fact that the former method of journalizing all entries is not now followed, as a rule.

The Ledger, when all the entries are posted, on one side ordinarily shows credits to ourselves for our capital (which the business owes us), credits to others for amounts the business owes them, credits to Bills Payable (obligations given in settlement of debts), and perhaps, credits to accounts showing gains. On the opposite side, debit accounts of parties owing us, debits to Bills Receivable (obligations of parties due us) debits to Merchandise Account, Cash Account, or other property accounts, and Expense Accounts, and others as the nature of the business may involve. I only mention some general features.

Debit Accounts are usually Assets.

Credit Accounts are usually Liabilities.

The exceptions are the accounts which are involved in the determination of gains or losses, such an Expense Account (which may have any number of sub-divisions), Interest Account and Profit and Loss Account. These accounts when at the debit are not assets, for they represent nothing and nobody, and if there were no profits to off-set them, would have to be charged to Capital Account,—but the usual course is once or twice a year to close the books (these periods are called fiscal periods), when an inventory of goods and possessions is taken.

We will suppose that we are doing a simple merchandise business, buying and selling. We shall have *charged* all our *purchases* to Merchandise Account, and we shall have *credited* all our *sales* to Merchandise Account. We will assume that our *purchases* have amounted to $100,000, and our *sales* to $90,000, but we find upon taking an inventory that we have goods on hand worth $25,000. Now, if we add the $25,000 to the $90,000 at credit of Merchandise Account, we have $115,000 as against a

cost of $100,000. It is evident to you, therefore, that we must have made $15,000 profit. But to arrive at that in book-keeping fashion, we debit Merchandise Account with $15,000 profit, and credit Profit and Loss Account, bringing down a balance to the new Merchandise Account of $25,000, being the $10,000 balance already at the debit plus the $15,000 profit charged, making $25,000 as the value of merchandise and the debit to Merchandise Account with which to commence the new fiscal period. Now we find that we have $15,000 to the credit of Profit and Loss, but we have various expense and other debit accounts affecting the results of the business, and we debit Profit and Loss and credit these various accounts with their respective amounts; (we may have also credit balances to other accounts, such as Interest—affecting the result, and these we credit to Profit and Loss), and assuming that as a net result of these various debits and credits to Profit and Loss we have a balance of $10,000, this then is the net gain for the year, and we transfer it to our individual account by debiting Profit and Loss and crediting our account.

This is an illustration of what takes place, with more or less modification as to the number, character and distribution of accounts, in every business whose records are kept by Double-Entry Book-keeping, in the determination of Profits and Losses. In large concerns it is usual to adjust interest to the fiscal period by calculating amount of interest they would receive and pay to that date if all accounts were to be closed, and if the balance is in their favor, charging new Interest Account and crediting old Interest Account, or the reverse if the balance is against them.

There is a remarkable feature in Double-Entry Book-keeping,—its universality. When you buy from A and credit him and debit your Merchandise Account, A on the other hand debits you and credits *his* Merchandise Account, and so the world over are the business records interwoven by the Double-Entry System.

Another very remarkable thing is, that the principles involved in Double-Entry Book-keeping have not undergone any change. Forms of books without number have been devised to facilitate and subdivide work, but the underlying, fundamental rules stand, and this fact alone is sufficient to demonstrate its great and abiding value.

Now I have tried to set before you the basic principles of book-keeping, and though I have been obliged to introduce some features of practice, I trust I have made myself clear. The next point I wish to talk about is book-keepers. There is no occupation which admits of such variation in capacity as book-keeping. Take a book-keeper whose experience has been mercantile and put him in a factory, and, as a rule, he will be as much at home as if he had been transported to a foreign land. Ordinarily, however, a book-keeper can go from one house to another in the same line and adapt himself to the changes in forms. Many, because of their clerical accuracy in making entries, in posting them and taking off trial balance sheets, pose as expert accountants, but very few have any real capacity for arranging and opening accounts adapted to the wants and character of a new business or venture. This is properly the work of an accountant, and involves not only a knowledge of accounts, but of affairs, and this knowledge of affairs is the feature distinguishing the accountant from the book-keeper. The accountant is synthetic as well as analytic.

Your education is supposed to fit you for the practical or material side of business, the utilization of natural and mechanical forces in their various forms. To this you want to add the knowledge of the relation of your operations to financial results. This knowledge coupled with the ability to compare the results of your operations with the results of others, begets an ability to analyze and dissect affairs in general, and you become in time "men of affairs." To this end you should all look, you should all be men of affairs. I know of nothing that will add more to the value of your professional and technical acquirements than a knowledge of accounts sufficient to enable you to make a clear and intelligible showing of the operations and results of any venture or work in which you may be engaged.

In my experience of over thirty years, I have never found a clerk or book-keeper who could not calculate interest in the manner usual in commercial life, but I have never found one who could explain the rule by which he arrived at the result. Thousands of men are engaged in keeping books (and in other pursuits for that matter), who cannot state (for they do not know)

the primary rules governing their work. They know "how" in a more or less limited way, not "why." If I had the power, I would place on the walls of every class-room in the land two precepts:

First,—"Learn the WHY and you will always know HOW!"

Second,—"Never expect something for nothing." For in life as in book-keeping, for every debit there must be a credit, and if these precepts are followed, there will be an ability to do and a willingness to give a fair equivalent in exchange for anything and everything desired.

And in conclusion, to you I would say,—give your time, energy and ability to, and persevere faithfully, in your pursuits, and while you may differ in the measure of your success, you will all have success in a measure, notwithstanding differences in opportunities.

THE FACULTY OF STEVENS INSTITUTE.

As many of our readers are no doubt aware important changes have occurred since our last issue, in the Faculty of the Institute.

The death of Prof. De Volson Wood on the 27th of June and of Prof. Alfred M. Mayer on the 13th of July created vacancies in two of the prominent departments, the filling of which has been combined by the Trustees with some changes in the curriculum which they believe will conduce to increased efficiency in the work of the Institute as a School of Mechanical Engineering of a strictly technical character.

When the Institute was first organized during 1870, it was necessary to proceed in a somewhat tentative manner in laying out the course which was to be pursued, because the entire matter was a new one. In other words no school fitting young men for the profession of Mechanical Engineering, as the same is carried on in this country, had ever been organized, and it was only to be determined by experience exactly what course of instruction would be best adapted for this purpose.

Accordingly, in providing for a department of Physics for example, the Trustees considered that this department should have a very broad scope and appointed as its head, in Prof. Mayer, one of the ablest Physical Investigators of this or any other country, a man whose researches have contributed largely to the progress of Physical Science in every direction; in light, in heat, in sound, in electricity and in magnetism.

As, however, the Institute, year by year, settled down to its practical work of educating Mechanical Engineers, it appeared that within the limits of time available to its students, it would only be possible, in addition to a general knowledge of the laws and facts of Physics, to give them special instruction of a practical nature in those lines of Physics bearing directly on Engineering.

Now it has most opportunely come about that one of the graduates of the Institute, Prof. D. S. Jacobus, who has been for

many years a member of its Faculty, developed a remarkable capacity both as an investigator in the domain of Engineering Physics and as an instructor in teaching others how to apply the methods and apparatus required in this subject.

In the new organization of the Faculty the Trustees have placed the portion of the department of Physics involving the Physical Laboratory, under the charge of Prof. Jacobus, with the title of Prof. of Engineering Physics in addition to his former title of Prof. of Experimental Mechanics, as suggesting the specialization of the work to which allusion has been already made.

The instruction in General Physics has been intrusted to Prof. W. E. Geyer, who has been connected with the Institute from its opening, who has for many years occupied the Chair of Applied Electricity and who during the long illness of Prof. Mayer took charge of the instruction in General Physics then belonging to his Chair.

Prof. Geyer will retain his charge of the Department of Applied Electricity with the assistance of Prof. Albert F. Ganz, who receives the title of Assistant Professor of Applied Electricity, and Mr. W. I. Thomson, Instructor in the same department.

Turning next to the Chair of Mechanical Engineering vacated by the death of Prof. Wood: this has been filled by the appointment of Prof. James E. Denton, who both by reason of his remarkable combination of mathematical capacity with practical familiarity with machine construction and his special experience as Professor of Experimental Mechanics and Shop Work for so many years in the Institute, is phenomenally fitted to take the leading position in this fundamental department.

In assuming the duties of this Chair, Prof. Denton will by no means give up the oversight and direction of the Work Shops and of the instruction in Experimental Mechanics, in which he will be aided by Prof. Jacobus and Professor R. M. Anderson, who has been transferred from his former Chair of Asst. Prof. of Applied Mathematics to that of Assistant Prof. of Experimental Mechanics and Engineering Physics.

In order to relieve Prof. Anderson of that part of his former

duties which related more directly to Mathematics, Mr. Frederick L. Pryor of the class of '97 has been made Instructor in Mathematics. H. M.

The list of the Faculty will then be as follows :

Henry Morton, Ph. D., President.

J. Burkitt Webb, C. E., Professor of Mathematics and Mechanics.

Charles W. MacCord, A. M., Sc. D., Professor of Mechanical Drawing.

Albert R. Leeds, Ph. D., Professor of Chemistry.

Charles F. Kroeh, A. M., Professor of Languages

Rev. Edward Wall, A. M., Professor of Belles-Lettres.

Coleman Sellers, E. D., Professor of Engineering Practice.

James E. Denton, M. E., Professor of Mechanical Engineering.

William E. Geyer, Ph. D., Professor of General Physics and Applied Electricity.

Thomas B. Stillman, Ph. D., Professor of Analytical Chemistry.

David S. Jacobus, M. E., Professor of Experimental Mechanics and Engineering Physics.

Adam Riesenberger, M. E., Ass't. Prof. of Mechanical Drawing.

William H. Bristol, M. E., Ass't. Prof. of Mathematics.

Robert M. Anderson, M. E., Ass't. Prof. of Experimental Mechanics and Engineering Physics.

Samuel D. Graydon, Ass't. Prof. of Mechanical Drawing.

Albert F. Ganz, M. E., Ass't. Prof. in Applied Electricity.

Franklin DeR. Furman, M. E., Instructor in Mechanical Drawing.

Albert R. Lawton, A. M., Instructor in Languages.

Morgan E. Craft, M. E., Instructor in Chemistry.

William I. Thomson, M. E., Instructor in Applied Electricity.

Frederick L. Pryor, M. E., Instructor in Mathematics.

Matthew Lackland, Instructing Mechanic in Work Shop.

RESOLUTIONS ADOPTED BY THE FACULTY

ON THE DEATH OF PROFESSOR WOOD.

At a meeting of the Faculty of the Stevens Institute of Technology, September 21st, 1897, the following resolutions were unanimously adopted :

Resolved, That in the death of our esteemed co-worker, Professor De Volson Wood, the Faculty of the Stevens Institute of Technology has sustained the loss of one of its most valued members, a man of untiring energy in his devotion to the welfare of this Institution, of a noble and Christian character, which made every one respect and honor him, and of a kindly spirit and earnest purpose, which won the love of all those working under his instruction ;

Resolved, That as we survey his career we can but feel that his was a successful mission, and that there still lives the influence of his teachings, which can but grow apace, and in cherishing his memory we can best prove the love and veneration which we feel by borrowing inspiration from the example of a life well spent ;

Resolved, That we extend to his family our sincerest sympathy in their great bereavement, and that we forward them a copy of these resolutions.

RESOLUTIONS ADOPTED BY THE FACULTY

ON THE DEATH OF PROFESSOR MAYER.

At a meeting of the Faculty of the Stevens Institute of Technology, September 21st, 1897, the following resolutions were unanimously adopted :

Whereas, God, in his infinite wisdom, has seen fit to remove from our midst our beloved colleague, Alfred Marshall Mayer.

Resolved, That in his death we, the Faculty, lose in him a faithful friend and a genial companion ;

Resolved, That the Institute loses in him one of its ablest instructors, a wise counselor, and a true gentleman, whose winning and urbane manners endeared him to all who had the good fortune to know him ;

Resolved, That the scientific world loses in him an ingenious experimenter, and an original and indefatigable investigator in the domain of physical science, the fruits of whose researches constitute a permanent addition to human knowledge ;

Resolved, That this inadequate testimonial of our appreciation and sympathy be spread upon the minutes, and transmitted to his bereaved family.

OBITUARY.

LOUIS BOWMAN WALKER.

Louis Bowman Walker of the class of '91 died suddenly of heart failure, at his home in Elizabeth, May 11, 1897.

Mr. Walker was born in New York City, February 25, 1869, but in 1873 the family moved to Morristown, N. J., which was his home till 1891.

In his early life his education was obtained at the Morris Academy, Morristown, almost entirely, though one season was spent at the school at Tivoli on the Hudson. He then entered Stevens in 1887 and was graduated in 1891.

In the latter year he entered the employ of the Baltimore Sweating Refining Co., in Baltimore, with whom he remained two years. He was then made assistant superintendent of the Old Dominion Copper Co., of Globe, Arizona, which position he held till the property was sold to a Boston syndicate in 1895.

He came East again, and was engaged by the Mountain Copper Co., Ltd., of England, by whom he was sent to their mines in Shasta Co., California, on special work. He returned in the early part of 1896 and was made manager of their smelting works at Elizabethport, which position he held at the time of his death. The labor of getting these works into condition for receiving and treating the matter which was shipped there from California was very great, but was steadily and successfully carried out to the entire satisfaction of the owners, whose thorough confidence and esteem Mr. Walker won.

He worked very hard during the winter of 1896–97, and in some of the time that he was not feeling well, but nothing serious was apprehended on the latter account.

On [illegible] he went home from the works as usual [illegible] he was attacked [illegible] the cause of his death being heart failure. [illegible] the latter two years old.

OBITUARY.

FREDERICK HARLOW WOOD.

On Thursday, September 2d, 1897, at his home in Upper Montclair, N. J., Frederick Harlow Wood died after a long siege of sickness. The funeral services were held on the following Saturday, after which the remains were taken to Concord, Mass., for interment.

Mr. Wood was in his 26th year. He was born in Concord, his final resting place, but spent most of his short life in Montclair. He attended Stevens School, entering the Institute on the scholarship awarded him at the school. His standing in college was uniformly high; his fine, manly character had won for him the esteem of all his fellow students when in 1893 the class dispersed to join the ranks of engineers.

When mentally well equipped for his chosen profession it must have been a severe trial for him to discover that his physical powers failed him, due perhaps to the arduous application to study while at school; and that he was unable to take up the real work which held such a promising future.

He went to California, hoping to be benefitted by the climate, but only temporary relief was afforded to his lung trouble and he returned to Montclair to spend the last years of his life. Here an attractive house stands as one of the creations of his mind, a work which kept him employed when books seemed too heavy and unreal.

All through his illness he endured without a murmur, always gentle and working to some useful end until the last day when he understood the call from the great Father and closed his eyes, brave to the last.

W. K., '97.

OBITUARY.

JOSEPH [illegible] COTTIER.

Joseph [illegible] Cottier, of the class of '94, died in Paris, France, August [illegible], 190[illegible], of typhoid fever.

Mr. Cottier and his travelling companion, Prof. A. L. [illegible], of Jersey City, N. J., left New York June 3[illegible] to make a bicycle tour through France. They had ridden about four hundred and eighty miles and were near Paris when both were taken with typhoid fever, which proved fatal in both cases. Mr. Cottier's remains were brought to this country and funeral services were held at his late residence, [illegible] Congress Street, Jersey City Heights, N. J., on the 30th of August. The burial took place the following day in Greenwood Cemetery.

Mr. Cottier was born May 2[illegible], 187[illegible], at Jersey City, N. J. His early education was received at Public School No. [illegible] of that city, at the institution Le Beque, Nogent-sur-Marne, France, and at the Stevens School. From the latter place he won the Stevens scholarship and entered the Stevens Institute in 1890 and was graduated with the class of '94 with the degree of M. E. While at Stevens he showed exceptional ability as a student, especially in mathematics, where he distinguished himself by solving a number of problems in which many of the ablest students of former times had failed. He was quiet and unassuming and was loved and respected by his classmates, for whom he delivered the Salutatory address at the commencement exercises.

After graduation he secured several positions in mercantile establishments, none of which, however, offered opportunities for him to pursue the studies for which he still entertained a fond desire. Accordingly, in the autumn of 189[illegible] he made application for and secured an appointment as University Scholar in Mechanics in the School of Pure Science at Columbia University. The following account and estimate of Mr. Cottier's ability is taken from a letter received from Professor R. S. Woodward, of Co-

lumbia University: "He pursued mechanics as his major subject and chose mathematics and education as minor subjects. At the end of the academic year 1895–6 he took the degree of Master of Arts. At the same time he was appointed to a University Fellowship, one of the highest honors conferred upon graduate students by Columbia. Continuing his studies during the year 1896–7 he completed nearly all the lecture work essential for the degree of Doctor of Philosophy. By reason of his exceptional merits as a student he was reappointed Fellow in Mechanics for the year 1897–8. It was his expectation and our desire that he would have this entire year to devote to the completion of his doctorate dissertation on fluid motion and pressure.

"Since he was a fellow in my department and pursued work under my immediate direction, I feel qualified to judge somewhat critically of his merits as a student and man. During two years of association with him I came to hold him in the highest esteem. He had a singularly clear and penetrating mind and I confidently anticipated a brilliant career for him. He did not hesitate to attack the most difficult questions and he rarely failed to throw light on them. His industry was indefatigable, and he came to read the most profound works in his special subject of study—hydromechanics—with astonishing ease and thoroughness. At the same time, he was one of the most modest and unassuming of men, winning the cordial esteem of his associates by his kindly and dignified manners.

"Mr. Cottier left two important papers in my hands for publication. One of these, 'On the Application of the Equations of Hydromechanics to the Terrestrial Atmosphere,' is now about ready to appear in the Weather Review, published by the United States Weather Bureau. The other, on the applications of curvilinear coördinates to the equations of hydromechanics will appear later in the *Mathematical Review*, published at Clark University."

OBITUARY

[illegible] TATAR.

[illegible] Heights [illegible] His illness was [illegible] brought [illegible] and [illegible] other [illegible]

[illegible] Abraham V. [illegible] New York Medical College and Hospital for Women, [illegible] granddaughter of Dr. [illegible] little over twenty-three years old.

His early education was obtained at the West Fifty-fourth Street Grammar School, from which he graduated and then entered the College of the City of New York. This after he [illegible] and entered Stevens with the class of [illegible] and graduated with [illegible] the same. After graduation he [illegible] the employ of [illegible] electrical [illegible] Westinghouse Church, Kerr [illegible] with this latter concern he was offered and accepted the position of assistant manager of the Bullock [illegible] Company, which place he filled at the time of his death.

[illegible] chosen field was that of electricity and [illegible] articles on that subject to various [illegible] he had invented an electric register [illegible] by means of which the depth of water was [illegible] He was a member of the American Institute of Electrical Engineers.

He was [illegible] a member of the First Naval Battalion of New York, and was the chief signalman of the non-

commissioned staff. He made an extended survey of Long Island, which established a complete signal system and called forth special commendation from the Navy Department as being the only record of its kind in the possession of the department, and as a model for others.

While at the Institute he was a prominent member of the various college and class societies. Personally, he was of a peculiarly bright and lovable disposition. He had many warm friendships, and would do anything to aid a friend, while of them he exacted nothing. His cheerful manner attracted those who met him, and his fixity of purpose, combined with the nobility of his principles, commanded the admiring respect of all.

C. W. MACC., JR., '94.

OBITUARY.

EDWIN HUTCHINSON.

Edwin Hutchinson of the class of '95 died at his home in Brooklyn, N. Y., July 7th, 1897.

While in the employ of the Townsend Furnace and Machine Shops at Albany in the fall of 1896 he was taken with an illness which was attributed to the drinking water of that place. He returned to his home but did not secure any relief. It is believed that the ulceration which followed developed into a cancer of the colon from which he finally died after about ten months of suffering and intense pain, all of which he bore with great fortitude and with the hopefulness of ultimate recovery.

Mr. Hutchinson was born July 6th, 1871, at Hackensack, N. J. His early education was received at Gloucester, Mass., and later at the Polytechnic Institute, Brooklyn, and at the Stevens Preparatory school from which he entered the Stevens Institute in 1891 and was graduated with the class of '95. After graduation he entered the employ of the Western Union Telegraph Company where he distinguished himself by drawing plans for a dredging machine for one of the stockholders of that Company.

He was exceedingly well developed and possessed a large and splendid physique and a strong mind. The combination of these qualities enabled him to become a very successful athlete. Yachting, in which he was expert was his favorite pastime. He played with the Orange Foot-ball team in the fall of 1895, when they won the National Championship from the Crescent Club.

While in the Institute he took a great interest in all the athletic sports in which he was exceedingly adept, and for three years played in prominent positions on the 'Varsity Foot-ball team. At the same time he was a good student and on account of his all-around manly qualities was a general favorite among his classmates and those who knew him.

INSTITUTE NOTES.

WE WOULD LIKE TO OBTAIN a number of the early copies of the INDICATOR, in order to complete files, and will pay 75 cents for each of the following copies:

VOL. 1......NO. 4.
VOL. 2......NOS. 2, 4, 7 and 9.
VOL. 3......NOS. 1, 2, 5 and 8.

PROFESSOR MACCORD is contributing a series of articles to the educational department of *Marine Engineering* on "The Art of Making of Mechanical Sketches, for Marine Engineers."

PROFESSOR LEEDS was in attendance at the meeting of the British Association for the Advancement of Science held at Toronto, Canada, last August. Over one thousand members were present including three hundred from the American Society of the same name, of which Dr. Leeds is a Fellow. He is also a corresponding member of the British Association.

THE PAPER BY DR. STILLMAN on the Solubility of Aluminium in Nitric Acid which was read at the recent meeting of the American Association for the Advancement of Science, and published in the July number of the STEVENS INDICATOR, has also appeared in the *Journal of the American Chemical Society* and in the *Chemisches Central-Blatt*, Leipzig, Germany.

DR. COLEMAN SELLERS' discussion of a paper on "The Installation of the Niagara Falls Power Company" is presented in full in Vol. XIV. No. 2 of the *Proceedings of the Engineers' Club of Philadelphia*.

PROFESSOR SELLERS received a large delegation from the members of the British Association for the Advancement of Science, which held its convention at Toronto in August, and personally conducted them through the large power house of the Niagara Falls Power Company. PROFESSOR SELLERS also received the members of the Association of the Edison Illuminating Companies which held their eighteenth convention at Niagara Falls, September 14th–16th and accorded them every opportunity to inspect the workings at the power honse.

PROFESSOR JACOBUS was present at the meeting of the American Association for the Advancement of Science and read a paper on "Flue Gas Analysis in Boiler Tests," which was abstracted in *The Electrical Engineer*, September 16th. *The Engineer* of September 18 contained an extensive abstract from Prof. Jacobus' lecture on "Artificial Light; Modern Methods Compared; Electric-Incandescent, Welsbach, Acetylene," which was delivered before the Franklin Institute, Philadelphia. The abstract was headed "Explosive Properties of Acetylene." An abstract from Prof.

[illegible]

[illegible]

[illegible]

[illegible] Chemistry at the Institute [illegible]

[illegible] Twenty-fifth Anniversary of [illegible] a large number of excellent illustrations [illegible] Owing to several [illegible] charge of the book, an [illegible] a large and [illegible] now progressing as rapidly as [illegible]

[illegible] Dr. Stillman has recently [illegible] amongst which is the following:

1st. [illegible] for the rapid determination of carbon in steel. This method was first introduced in the German steel works in 1895. Carbon can be determined in steel by this apparatus in five minutes.

2d. A gas combustion furnace from Berlin, Germany, model of Dr. [illegible], with a [illegible] drying apparatus.

This furnace has been used by the students of the Institute for the complete analysis of coals and fuels, in connection with the determination of the heating power of the same.

3d. A Vicat apparatus for the determination of the time of the setting of Portland cement.

4th. A set of Gillmore wires, used for the same purpose as the Vicat apparatus. Both of these instruments were required and used by Messrs. [illegible] and [illegible], '97, for experiments recorded in their graduating thesis, June, 1897.

5th.—An Orsat-Muencke apparatus for the determination of carbon dioxide, carbon monoxide, oxygen and nitrogen in fuel gases. This in connection with an Elliott gas analysis apparatus and a set of Hempel's Gas Pipettes, constitutes a well equipped laboratory for the analysis of all varieties of combustible gases and the determination of their thermal values.

A MEETING OF THE EXECUTIVE COMMITTEE of the Alumni Association of Stevens Institute was held at the office of Mr. John Lieb, Jr., October 7th, 1897. The following members were present :—

John W. Lieb, Jr., President ; Robert M. Dixon, Hosea Webster, Franklin De R. Furman, Gordon Campbell, Wm. H. Bristol, Ernest H. Foster, Wm. R. King, Lewis H. Nash, E. A. Uehling.

Mr. Furman presented the question of the election to membership of five members of the last graduating class whose names were not presented in advance of the annual metting as provided for in Article III., section 5 (a) of the constitution. Section 5 (b) however provides that candidates for membership from the graduating class of any year may be elected by ballot by the Executive Committee in advance of the annual meeting of that year.

Mr. Uehling therefore moved that the following gentlemen be elected members of the Alumni Association and the action of the Executive Committee be referred for ratification to the Alumni Association :

W. T. Handforth, Wm. D. Ennis, Alex B. Macbeth, Edgar T. Powers, Warren W. Chapin. Motion carried.

Mr. Dixon moved that a committee be appointed to draw up suitable resolutions expressing the loss felt in the death of Prof. Alfred M. Mayer and Prof. De Volson Wood, and that a letter from Mr. Manning on the subject be submitted to such committee. The motion was carried and the President appointed Messrs. Dixon, Campbell, Uehling and Parsons.

Mr. Furman presented the question of relieving the INDICATOR of the payment of the interest on a sum of $600, loaned by the Alumni Association to the INDICATOR several years ago on the ground that the Treasurer of the Alumni Association holds the INDICATOR funds which includes, for a large part of the time, about one-half of the loan and he also holds a large sum in advance subscriptions, on both of which items the Association receives the interest. This interest, although properly belonging to the INDICATOR has never been charged against the association. Mr. Foster moved that the Treasurer be directed to make report of the standing of the INDICATOR Fund including a copy of the resolution by which the loan was first authorized.

The motion was carried.

Mr. Foster moved an adjournment until the first Thursday in November. Motion carried.

GORDON CAMPBELL, Recording Secy.

PROF. W. A. RODGERS OF ALPHA UNIVERSITY visited the Institute recently and examined the apparatus used for instruction in the department of Experimental Mechanics with a view to establishing a course in his own institution.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

Bennett, Frank, West Orange, N. J.
Berliner, Richard W., Atlantic Highlands, N. J.
Botchford, Henry J., Woodland, Ulster Co., N. Y.
Bradley, Edgar L., Jr., 3 Duncan Ave., Jersey City, N. J.
Carey, Paul C., 7 Humboldt St., Newark, N. J.
Chasteney, C. D., Rutherford, N. J.
Chatard, Wm. M., 516 Park Ave., Baltimore, Md.
Close, Howard Brandon, "Audabon," Broadway and 39th St., N. Y. City.
Coley, Clarence L., 54 West 97th St., New York City.
Davey, Leigh H., 241 Tonnele Ave., Jersey City, N. J.
Daw, W. L., Towanda, Pa.
Deitz, Carl Fr., 606 Hudson St., Hoboken, N. J.
Ellinger, Edgar, 215 East 79th St., New York City.
Foppes, Alfred, 56 Christopher St., Montclair, N. J.
Gibson, Fredrick, 25 Kearney St., Newark, N. J.
Goode, Curtis Bates, Nyack, N. Y.
Hamilton, E. C., 60 West 76th St., New York City.
Haussling, Joseph H., 3 Railroad Place, Newark, N. J.
Holcombe, Emley M., Lambertville, N. J.
Howland, Horace F., 1406 Dean St., Brooklyn, N. Y.
Jenks, Gedney, Weehawken, N. J.
Lawson, James L., 715 Park Ave., Hoboken, N. J.
Layat, Felix, Scotch Plains, N. J.
Lidgerwood, James G., Morristown, N. J.
Lyon, Frank F., 143 Hewes St., Brooklyn, N. Y.
Le Page, Clifford, 468 12th Ave., Mt. Vernon, N. Y.
Lewis, A. S., 298 Halsey St., Brooklyn, N. Y.
Lewis, N. E., 209 West 8th St., Plainfield, N. J.
Litchfield, Wm. B., 13th Ave. and 55th St., Brooklyn, N. Y.
MacNaughton, D. S., 46 Madison Ave., Jersey City, N. J.
Merritt, Chas. F., 99 Ocean Ave., Jersey City, N. J.
O'Neill, R. J., 15 South 10th St., Newark, N. J.
Palmer, E. E., 29 Queens Paik, Toronto, Canada.
Palmer, J. C., 29 Queens Park, Toronto, Canada.
Parker, Thomas K., 106 West 8th St., Bayonne, N. J.
Reese, F. I., Hackettstown, N. J.
Reitze, Geo., Jr.. 613a Hancock St., Brooklyn, N. Y.
Rittenhouse, L. H., Flemington, N. J.
Rosenheim, DeWitt R., 113 West 74th St., New York City.
Sander, G. H., 24 Ogden Ave., Jersey City, N. J.
Schroeder, Edw. J., Jr., 223 Pavonia Ave., Jersey City, N. J.
Scott, A. D., 244 First St., Jersey City, N. J.
Siegele, A., Jr., 135 Lenox Road, Flatbush, Brooklyn, N. Y.
Sinclair, J. J., Morristown, N. J.
Stryker, W. A., 35 Highland Ave., Jersey City, N. J.

[illegible]

[illegible] CHEMISTRY [illegible] has been [illegible] will show the favorable [illegible] of the book.

[illegible] states: "This volume [illegible] chemist and especially to [illegible] the examination of the materials of engineering. [illegible] portions of this work are the numerous examples [illegible] calculation whereby the results [illegible] practical work [illegible] example, in the calculation [illegible] determining the heating value of coal and [illegible]

[illegible] book should [illegible] place as a standard of reference in the working [illegible] analytical chemist and chemical engineer."

[illegible] London, states: "Engineers will find this book [illegible] guide."

[illegible] states: [illegible] some of the principal subjects [illegible] analysis, analysis of [illegible] ingredients, chemical and [illegible] analysis and valuation of [illegible] This last subject is treated [illegible] The style of [illegible] illustrations are good, and we [illegible] to engineers and to the [illegible] engineers."

[illegible] "Although this work is chemical in its [illegible] application and economic utilization of the substances [illegible] lost sight of. It can be used with equal profit [illegible] superintendent or engineer."

[illegible] this volume. It is neither strictly theo[illegible] pragmatism or practice, but it stands among [illegible] stands among men, a link between the professor [illegible]

[illegible] information in this book has not heretofore been [illegible] the technical part of it should be much in[illegible] judicious and careful selection of infor[illegible] *Engineering Chemistry.*"

Prof. R. H. Thurston, Director of Sibley College, writes to Dr. Stillman: "I see at a glance that it is an admirable compendium of valuable material in engineering chemistry and as it is in a field almost entirely uncultivated. I am sure of its success."

Geo. Gibbs, M. E., '82, Chicago, Milwaukee & St. Paul R. R., writes: "I must congratulate you upon the very practical method of treatment followed and the book will fill a long felt want in Industrial Chemistry, especially as applied to railway needs."

L. S. Randolph, M. E., '83, writes: "I have carefully examined your book on 'Engineering Chemistry' and want to congratulate you most heartily on the same. Such a work has long been needed."

Many other letters have been received from prominent engineers and chemists speaking in high terms of the work.

A LETTER FROM A CORRESPONDENT IN LONDON, ENGLAND, states that there are fourteen Stevens graduates in that city and there is some talk of forming a Stevens club. The INDICATOR would like to see this club organized without delay, and not only this one but others in various centres where a number of Stevens men are to be found. Such clubs would not only be of benefit to the local members through the exchanges of ideas and discussions at meetings, but would engender a fellowship and activity that would do much to advance the interest of their Alma Mater in their respective localities and at the same time make the Stevens degree, which they hold the more respected. In other words, such clubs would help to "boom" things generally.

ENGINEERING SOCIETY. The First Regular Meeting of the Engineering Society for 1897–98 was held on Friday, Oct. 15, 1897. The election of officers resulted as follows:

President, Herbert R. Davies; Vice-President, MacM. N. Moore; Secretary, E. B. Smith; Treasurer, Allan C. Myers; Executive Committee, H. Brett, I. F. Baker, E. C. Grelle.

MacM. N. Moore, '98, delivered a paper on the Westinghouse High Speed Brake, and Mr. T. F. Dreyfus, '98, explained the method of Extracting Oil from Cotton Seed.

EACH OF THE CLASSES has met and selected its officers for the ensuing year as follows:

SENIOR CLASS.

President, Fraley Baker; Vice-President, W. G. Lunger; Secretary, E. B. Smith; Treasurer, Theo. F. Dreyfus; Executive Committee, Fraley Baker, H. R. Davis, E. C. Grelle, A. C. Myers, M. P. Walker.

JUNIOR CLASS.

President, R. P. Jennings; Vice-President, H. R. Sanson; Secretary, G. W. Martin; Treasurer, G. H. Beck; Executive Committee, J. R. Westerfield, J. Lidgerwood, P. C. Idell, C. Hoffman, R. Luqueer.

SOPHOMORE CLASS.

President, L. L. Merriam ; Vice-President, Wm. Jennings : Secretary, J. Ferguson ; Treasurer, E. R. Welles.

FRESHMAN CLASS.

President, W. A. Stryker ; Vice-President, E. L. Bradley : Secretary, F. Gibson ; Treasurer, Roy S. Younglove ; Historian, Alexander Allaire ; Foot-Ball Captain, H. J. Botchford.

THE STEVENS SOCIAL SOCIETY has elected the following officers : President, R. C. Post ; Vice-President, R. S. Scott, Jr.; Secretary, R. O. Luqueer ; Treasurer, R. O. Luqueer. The first dance of the season was held October 28th, the committee in charge being, A. I. Smith, R. O. Luqueer and E. S. Barlow.

THE PHOTOGRAPHIC SOCIETY has elected the following officers for the present year : President, R. P. Jennings, '99 ; Vice-President, R. J. Decker, '99 ; Secretary, J. R. Pierce, '00 ; Treasurer, C. Wachter, '99.

INSTITUTE PERSONALS.

'76.

GUS C. HENNING has been requested by the Vice-President of the International Committee which is endeavoring to secure uniform specifications and methods of inspection of metals, to serve on a sub-committee of American Engineers and to select the members that are to form it.

MR HENNING'S paper before the last meeting of the American Society of Mechanical Engineers, on the subject "A Pocket Recorder for Tests of Materials" was largely abstracted in an illustrated article in the *American Machinist* of July 15th; also, his discussion on gearing has been published under date of August 12 in the same paper, and is entitled "Casting Gears in Baked Molds."

THE FOLLOWING STATEMENTS regarding the work of ALFRED R. WOLFF are taking from *Heating and Ventilation* of June 25th, in which an article entitled "Heating and Ventilating Plants in a few Conspicuous New York Buildings" appears: "What is probably the largest and most costly heating and ventilating plant ever installed in any building in the world is that for the Hotel Astoria, at Thirty-fourth Street and Fifth Avenue. This magnificent structure' now nearing completion, was erected for Mr. John Jacob Astor. The plans and specifications for the complete power, heating, and ventilating plants were prepared by Alfred R. Wolff, consulting mechan ical engineer, Fulton Building, New York, under whose direction they were installed. The possibility of publishing a basement plan that would show the location of apparatus and other features of this installation is precluded by the immense size of the plant, an idea of which may be gained by the statement that the drawings of it, which were exhibited by Mr. Wolff at the recent commemoration of the twenty-fifth anniversary of the Stevens Institute, of which he is a graduate, had an aggregate area of 250 square feet." Among other large buildings in New York City, equipped with heating and ventilating systems designed by MR. WOLFF, are the new palatial private residence of Mr. Cornelius Vanderbilt, 5th Ave., between 57th and 58th Streets; the The Teachers College Building in West 120th Street; the New York Clearing House on Cedar Street; St. Luke's Hospital on Morningside Heights; the new elegant private residence of John Jacob Astor at 5th Ave. and 65th Street and the Carnegie Music Hall, 7th Ave. and 57th Street.

'77.

THE FOLLOWING PARAGRAPH IS TAKEN FROM *The Iron Age*:

"THE UEHLING CASTING MACHINE. For some time negotiations have been under way through the Union Trust Company, of Pittsburgh, Pa., between the Carnegie Steel Company, Limited, of Pittsburgh, and EDWARD

A. Uehling, of Newark, N. J., and James W. Miller, of Carnegie Building, Pittsburgh, looking to the purchase by the Carnegie Company of a half interest in the Uehling method of casting and conveying metals. The purchase was concluded last week, and the Carnegie Steel Company are now half owners of these valuable patents. It will be remembered that a full description of the Uehling method for casting and conveying pig iron, as in use at the Lucy furnaces of the Carnegie Steel Company, Limited, at Pittsburgh, appeared in *The Iron Age* of April 22, 1897. The results obtained from the carrier at these furnaces have been so satisfactory and the saving per ton of iron so great that arrangements were concluded some time since by which the four Duquesne and the nine furnaces at Edgar Thomson will be similarly equipped. Some important improvements have been made since the carriers were first built at the Lucy furnaces. The weight of the carrier has been increased, but the working parts have been very much simplified and the cost of construction has been lessened considerably. The casting machines that will be added to the Duquesne furnaces will represent all the improvements that have been made, and the construction of the machines will of course be radically different from those in use at Lucy furnaces. It is not the intention of the Carnegie Company to prevent other blast furnace owners from negotiating for the use of the Uehling casting machine, but it is not improbable the cost may be advanced owing to the improvements that have been made. The elimination of the sand, especially in basic iron for open hearth purposes, is one of the principal advantages which the method possesses. Negotiations are now in progress with a number of furnace owners who desire to add this machine to their equipment."

Oscar Antz contributed an article on "Machine for Mounting Air Hose" to the [illegible] *and R. R. Journal* for August.

[illegible] the data and information that was worked up [illegible] into a very interesting [illegible] Dynamometer Car.

[illegible] attended the eighteenth convention of the Association of [illegible] Companies held at Niagara Falls, September [illegible] several discussions, he read a paper on [illegible] the report of the committee [illegible]

[illegible] returned from a business trip [illegible] General Electric Company [illegible]

[illegible] from the [illegible] show what has been accomplished by the

Pintsch Compressing Company of New York. ROBERT M. DIXON has been the engineer and manager of this company for a number of years.

"The adoption of the Pintsch light by the Baltimore & Ohio Railroad necessitated the erection of additional Pintsch gas plants for the purpose of supplying the cars. New plants have been constructed and are now in operation at Baltimore, Washington and Pittsburgh, and all recent improvements in the construction and design of the special machinery required for the production of the gas have been incorporated. There are also plants at Cincinnati, St. Louis, Chicago, Cleveland, Indianapolis and Columbus, Ohio, so that the entire Baltimore & Ohio, and Baltimore & Ohio Southwestern system can easily obtain a supply of Pintsch gas for their cars, which are now equipped with the new light. The Pintsch light is now used by railroads the world over, and at present there are over 85,000 cars equipped with the system in this country and abroad. In order to fully supply the large number of cars with gas, over 45 Pintsch plants are now in operation in various parts of the country, extending from the Atlantic to the Pacific oceans, and from the lakes to the gulf, and new plants are being constructed as occasion requires."

'82.

"GEORGE GIBBS, who for a number of years has held the position of Mechanical Engineer of the Chicago, Milwaukee & St. Paul Railway, has been appointed to succeed the late Mr. David L. Barnes as Consulting Engineer to the Westinghouse Electric Company and the Baldwin Locomotive Works. Mr. Gibbs has been identified with and has originated many improvements in mechanical and electrical engineering applied to railroads, and is unquestionably better fitted for the important work to which he has been called than any other engineer. Mr. Barnes' successor could not have been more appropriately selected."—*American Engineer, Car Builder and Railroad Journal*, August.

CHARLES W. SCRIBNER has resigned his position as Instructor in Mechanical Engineering in the University of Pennsylvania and accepted a Professorship in the same subject in the North Carolina College of Agriculture and Mechanic Arts at Raleigh, N. C.

HOSEA WEBSTER has severed his connection with Henry R. Worthington and is now manager of the New York sales department of the Babcock & Wilcox Co., 29 Cortlandt street, New York City.

'83.

E. D. ESTRADA contributed a letter to the *American Machinist* of July 22d, discussing a method of computing the strength per square inch of cast iron.

JAMES E. SAGUE was in attendance at the thirtieth annual convention of the American Railway Master Mechanics' Association held at Old Point Comfort during the summer, and spoke from the standpoint of locomotive builders on the report of the committee on exhaust nozzles. Mr. SAGUE is

ALFRED G. MAYER, SC. D., has accepted an invitation from Prof. A. Agassiz to spend the winter among the Fiji Islands, exploring the coral reefs.

THE ECONOMICAL GAS APPARATUS CONSTRUCTION CO. (LIMITED), of which J. T. WESTCOTT is manager and treasurer, has removed its London office to 19 Abingdon Street, Westminster, S. W. *Engineering* of London, England, under date of July 23d gives a very extensive descriptive and illustrated account of the Carburetted Water-Gas Plant at Saltley Gas Works, Birmingham, as erected by The Economical Gas Apparatus Construction Co. (L'td.) and also describes the process of manufacture of the gas which was contributed by MR. WESTCOTT. This company commenced operations four years ago in Canada and during that time have installed eight plants in that country, two in the United States and six in England. A pamphlet written by MR. WESTCOTT on Carburetted Water Gas has been translated into Dutch by Mr. J. W. Moliju.

E. H. WHITLOCK has accepted a position with the National Carbon Co. of Cleveland, O., as expert engineer and superintendent's assistant.

'91.

THE DOW COMPOSING MACHINE CO., of which ALEXANDER DOW is engineer and manager, has removed to 150 Nassau Street, New York City.

GEORGE C. HOLBERTON AND GEORGE F. SUMMERS were present at the fifth annual meeting of the Pacific Coast Gas Association, held during the summer at San Francisco, Cal., and took active part in the discussion of several papers that were presented. The following is from the *American Gas Light Journal* of August 30: "MR. GEORGE C. HOLBERTON, who has acted as Superintendent of the Centralia (Wash.) Water Supply Company for a short while, resigned that position to accept the Superintendency of the Bangkok (Siam) Gas and Electric Light Company. The lighting concession in Bangkok is owned by an American named Bennett."

Mr. Summers has been appointed Superintendent of the gas department of the Hackensack (N. J.) Gas and Electric Company.

'93.

CHARLES T. BAYLESS is draughtsman in the motive power department of Compañia Limitada del Ferrocarril, Central Mexicano. He is located in Mexico City.

RICHARD E. CHANDLER and Miss Lena A. Luce, of Bozeman, Montana, were married at that place August 24th. Mr. CHANDLER, who has been taking a special course of study at Cornell University, is the author, in conjunction with Frederick Bedell and R. H. Sherwood, Jr., of an article on "The Predetermination of the Regulation of a Transformer with Non-Inductive Load," which appeared in *Electricity* August 11th, in the *American Electrician* for September, and in the *Electrical Engineer* of September 9th. Mr. CHANDLER is now Instructor in Mechanical Drawing in the University of Nebraska, at Lincoln, Neb.

LAMAR LYNDON, for several years a member of this class, has established himself at Yokohama, Japan, as an electrical engineer. *The Electrical Engineer* of August 26 contains a two-page illustrated article from him on "An Interesting Isolated Plant at Yokohama, Japan."

CHARLES T. RITTENHOUSE, editor of the *Electrical World*, was in attendance at the fourteenth general meeting of the American Institute of Electrical Engineers, held at Greenacre, Maine, July 26–28.

'94.

FRANK H. COYNE has disposed of his mining interests in California and will spend the winter in Washington, D. C.

JOHN B. KLUMPP, while temporarily located at Kansas City, Mo., in the interests of the United Gas and Improvement Co., was taken seriously ill with typhoid fever July 15th, and was confined to his room for more than two months.

'95.

T. E. BUTTERFIELD is with the Spartan Plaster Co., of Perth Amboy, N. J.

NESTOR RAMIREZ has secured a position in a mechanical establishment in La Guaira, Venezuela.

'96.

HARDING BENEDICT is Superintendent for the Hudson River Stone Supply Co., at Stoneco, N. Y.

W. J. A. BOUCHER is in the testing department of the Sprague Electric Elevator Co., at Watsessing, N. J.

JOHN P. EVERTSZ, HENRI GUTTIN and RUDOLPH BRUCKNER have formed a company and are about to erect a plant for the manufacture of artificial ice at Curacao, in the West Indies. At present all the ice used there is natural and is imported from the State of Maine.

J. B. FAULKS, Jr., is in the engineering department of the Standard Air Brake Co., 100 Broadway, New York City.

W. E. MALLALIEU is in the employ of H. R. Worthington at the Brooklyn works.

WILLIAM C. MORRIS and Miss Edna Bennett, of Jersey City, N. J., were married September 29th at the summer residence of the bride's mother, at Belmar, N. J.

WILLIAM T. RASMUS is in the street railway and lighting department of the Elmira (N. Y.) Municipal Improvement Company.

J. SCHIMMEL, JR., is in the general office of the Baltimore, Chesapeake & Atlantic Railway Co., 201 E. Baltimore Street, Baltimore, Md.

EDWARD M. TOBY is now in the employ of the National Contracting Co., of New York This company has the contract for the construction of a drainage system for the city of New Orleans, and expects to be busy there for several years. Mr. Toby's address is, Hennen Building, New Orleans, La.

ATHLETICS.

FOOTBALL.—The football prospects for the season are anything but encouraging at present. It is the same old story of a call for candidates, a few men responding and then finding no scrub team to line up against and give them practice. This condition of affairs is not the fault of Captain Hughes, but the individual football men in the college, whose enthusiasm ought to be as great as their ability to play the game.

Thus far two games have been played—The New York University having scored [illegible] points and the Irvings of Brooklyn [illegible], while Stevens has been unable to score as yet.

The schedule of the remaining games follows:

Oct. 23d. Rutgers vs. Stevens at New Brunswick.
" 27th. N. Y. U. " " " Hoboken.
" 30th. Knickerbocker A. C. vs. Stevens at Columbia Oval.
Nov. 3d. Rutgers vs. Stevens at Hoboken.
" 13th. N. J. A. C. vs. Stevens at Bergen Point.

ON ORANGE ATHLETIC CLUB this year are Kemble, Marshall, Koehler, Lancon and Coyne (who is captain), all of whom are old Stevens men.

TENNIS.—A tournament has been in progress this fall, and it is in a fair way toward being completed before the cold weather sets in. Scott is the class champion of '98; H. R. Sanson of '99; Durrie of 1900 and Howland of 1901.

THE CANE SPREE took place at the Cricket Grounds on Oct. 8th and resulted in a win for the Sophomores, the score being 3-0. Myers took the cane from Haussling, Ferguson did the trick with Bennett, and Percy won from Lewis. In the rushes, the Freshmen were beaten 29-5 and 25-0, but in the tug of war, pulled the Sophs all over the field.

BOOK NOTICES.

SLIDE-VALVES. By C. W. Mac Cord, Jr., M. E. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1897. 8vo. 161 pp.

This book is presented to the public with a view to meeting the wants of practical men. It contains the principles and methods of design and gives also an explanation of the principles of shaft-governors. It is profusely illustrated and the explanations are clear and concise. A large number of practical problems are given and fully worked out, affording parallel examples of many cases that might arise in practice. During 1895 and 1896 the author published a series of articles on "Valve-Gears" in *Power*. This new work contains the subject matter of these articles entirely revised and rearranged, and with a complete new set of cuts.

SEWER FLUSHING DIAGRAMS. By S. H. Adams, Civil Engineer (Sewerage) of York and Old Queen Street, Westminster, London, S. W. London: E. & F. N. Spon. New York: Spon & Chamberlain. 1897. Price, $5.00.

These diagrams are on heavy cardboard and show how far the discharge from a flush tank will give a self-cleansing velocity. They are based on the results obtained by actual tests made principally upon pipe sewers.

THE ENTROPY-TEMPERATURE ANALYSIS OF STEAM ENGINE EFFICIENCIES. With a blank diagram arranged for easy application to any concrete case. By Sidney A. Reeve, M. E., Adjunct Professor of Steam Engineering at the Worcester Polytechnic Institute. New York: Progressive Age Publishing Co.; 20 pages. Price, with diagram, 75 cents; diagram separate, 25 cents.

The text of this small book gives an elementary explanation of entropy: what it is and how to make use of it. The author shows an analogy between the conditions necessary to secure power from a given water supply and from steam and then defines entropy as "that property of a body which remains unchanged so long as no addition or subtraction of heat is made from without." Blank diagrams 18×30 inches have been prepared, by means of which the efficiency of heat engines may be readily analyzed with the aid of the explanations in the text which, in nomenclature and notation, are in accordance with Prof. Ewing's "Steam Engine and other Heat-Engines."

ELEMENTS OF DIFFERENTIAL AND INTEGRAL CALCULUS. By William S. Hall, E M., C.E., M.S. New York: D. Van Nostrand Co. 1897. Price $2.25 net.

As stated by the author in preface, the object has been to present the Calculus and some of its important applications simply and concisely, and yet to give as much as it is necessary to know to enter upon the study of those subjects which presume a knowledge of the Calculus.

The formulæ for differentiation have been established by the method

of limits. Immediately following the development of the rules for differentiation the corresponding inverse operations or integrations are given. The unity of the two branches of the Calculus is emphasized by this method of treatment.

A large number of examples are given including many practical numerical problems from mechanics and branches of applied mathematics. A table of Integrals, arranged for convenient reference, is also appended.

ACKNOWLEDGMENT IS HEREBY MADE OF THE RECEIPT OF THE FOLLOWING:

PROCEEDINGS OF THE AMERICAN GAS LIGHT ASSOCIATION, Vol. XIII. 1896. This book contains a large number of papers and discussions and is valuable as a work of reference on many up-to-date subjects in the gas light industry.

CATALOGUE OF THE MARINE IRON WORKS, of Chicago. This firm makes a specialty of marine machinery and complete steam yachts and launches. In their very neat catalogue is to be found excellent descriptions and illustrations of marine mechanisms as well as useful tables and information regarding the same.

CATALOGUE OF THE WILBRAHAM BAKER BLOWER CO., of Philadelphia, confined entirely to descriptions and illustrations of the Green Positive Rotary Pressure Blowers and Gas Exhausters. Various tables and information are given regarding the use of blowers in general.

SPECIAL CATALOGUE FROM HENRY R. WORTHINGTON, of New York, describing the Worthington Condensers—Jet, Surface and Self-cooling. Several topics of general interest are set forth, namely: Value of condensation with table showing per cent. gained by same; method for determination of amount of injection water; table of properties of saturated steam; table of mean effective pressures and table showing friction of water in pipes. Their new general catalogue No. 28 containing description of their Pumping Engines, Steam Pumps and Hydraulic Machinery has also been received.

CATALOGUE OF THE ST. LOUIS IRON AND MACHINE WORKS, St. Louis, Mo., describing the standard "St. Louis Corliss" engine, and showing by numerous line drawings the details of their engines.

CATALOGUE OF THE ANSONIA BRASS AND COPPER CO., setting forth the various physical and mechanical metal tests as applied to Tobin Bronze, which is offered for use in pump piston rods, yacht shafting, rudders, centre-boards, pump linings, condenser heads, fin keels, tube sheets, etc.

CATALOGUE OF UEHLING, STEINBART & CO. (LIMITED), of Newark, N. J., giving a full description of the principle of the Pneumatic Pyrometer, together with its application to blast furnaces, annealing and temperature furnaces, and to all industries in which high temperatures are important factors. Several charts are shown, giving autographic records, made by the Pyrometer, of the heat conditions as they existed at the time and place of application.

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Official Gazette, U. S. Patent Office. Vols. LXXII. and LXXIII.

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Journal für Praktische Chemie. Vol. LIX. Leipzig.
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Annales de Chimie et de Physique. January, 1897, to July, 1897.
Zeitschrift für Angewandte Chemie. January, 1897, to July, 1897.
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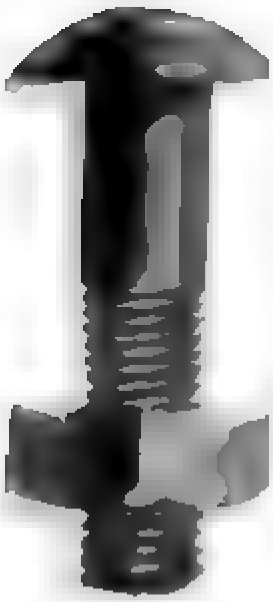

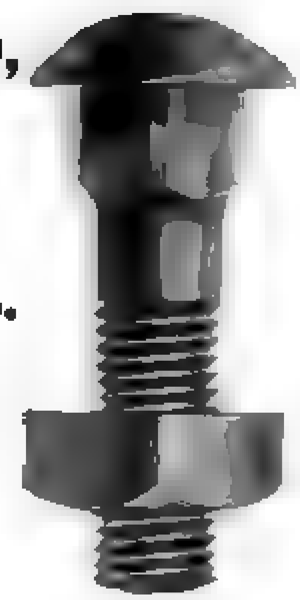

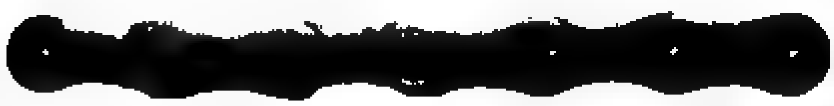

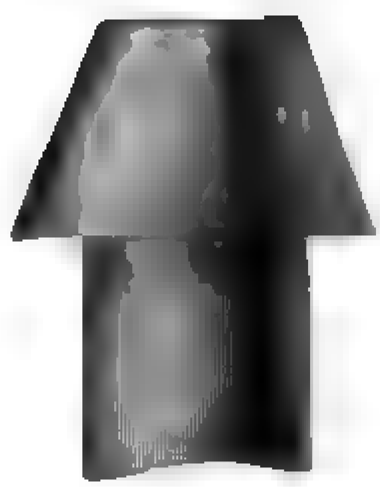

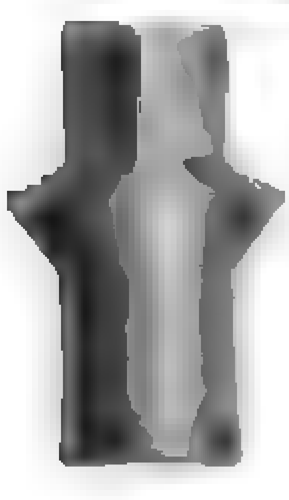

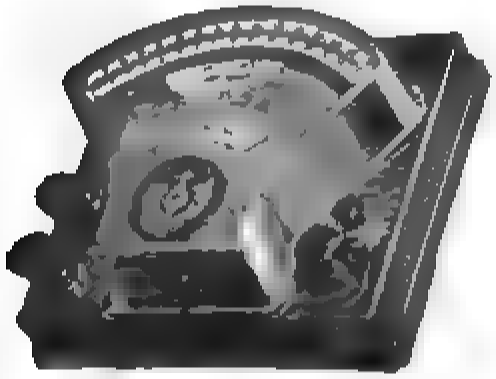

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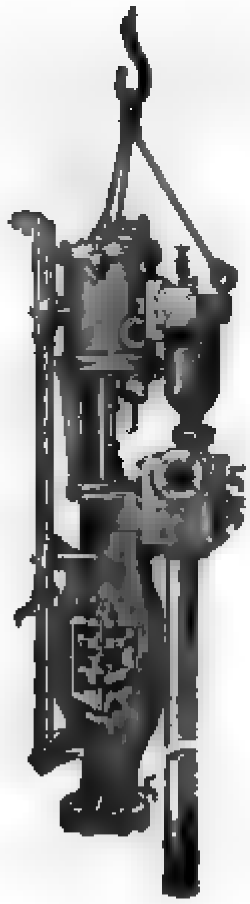

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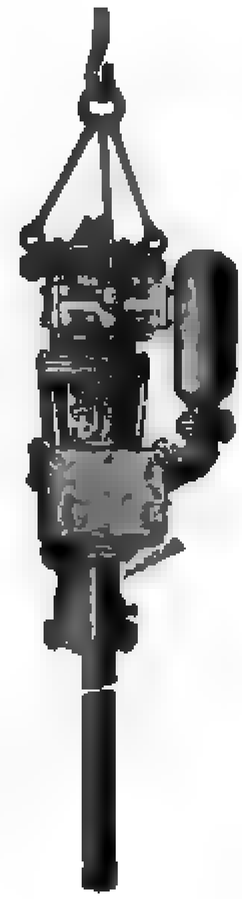

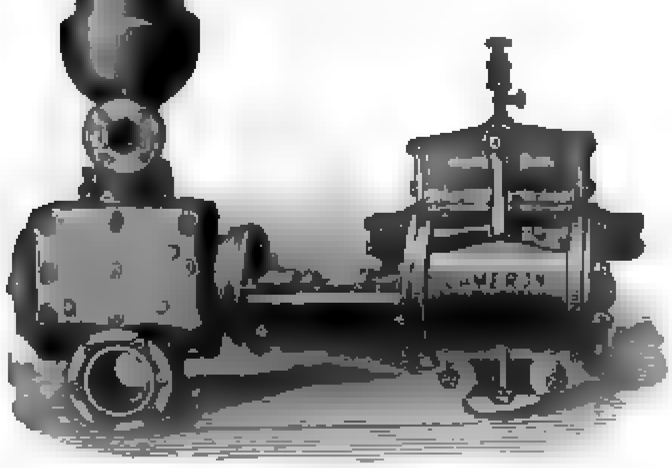

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